Page's Magazine

AN ILLUSTRATED TECHNICAL MONTHLY,

dealing with the

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MINING, AND ALLIED INDUSTRIES

VOLUME IV.

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Ptolemaic Temple. Nectanebo's Temple.

THE ASSOUAN RESERVOIR—VIEW AT SUMMIT LEVEL, WINTER 1902-3, SHOWING THE SUBMERGED TEMPLES OF PHILÆ, LOOKING EAST.

A short time before the Assouan Dam was opened and the region was flooded, the author dwelt for some time in a modest dwelling at a spot in the centre of the picture, which is now marked only by submerged palms. The hut, railway station, and the village of Shellal have all disappeared, the inhabitants removing to new quarters provided beyond the reach of the waters.

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THE IRRIGATION OF THE NILE VALLEY.

BY

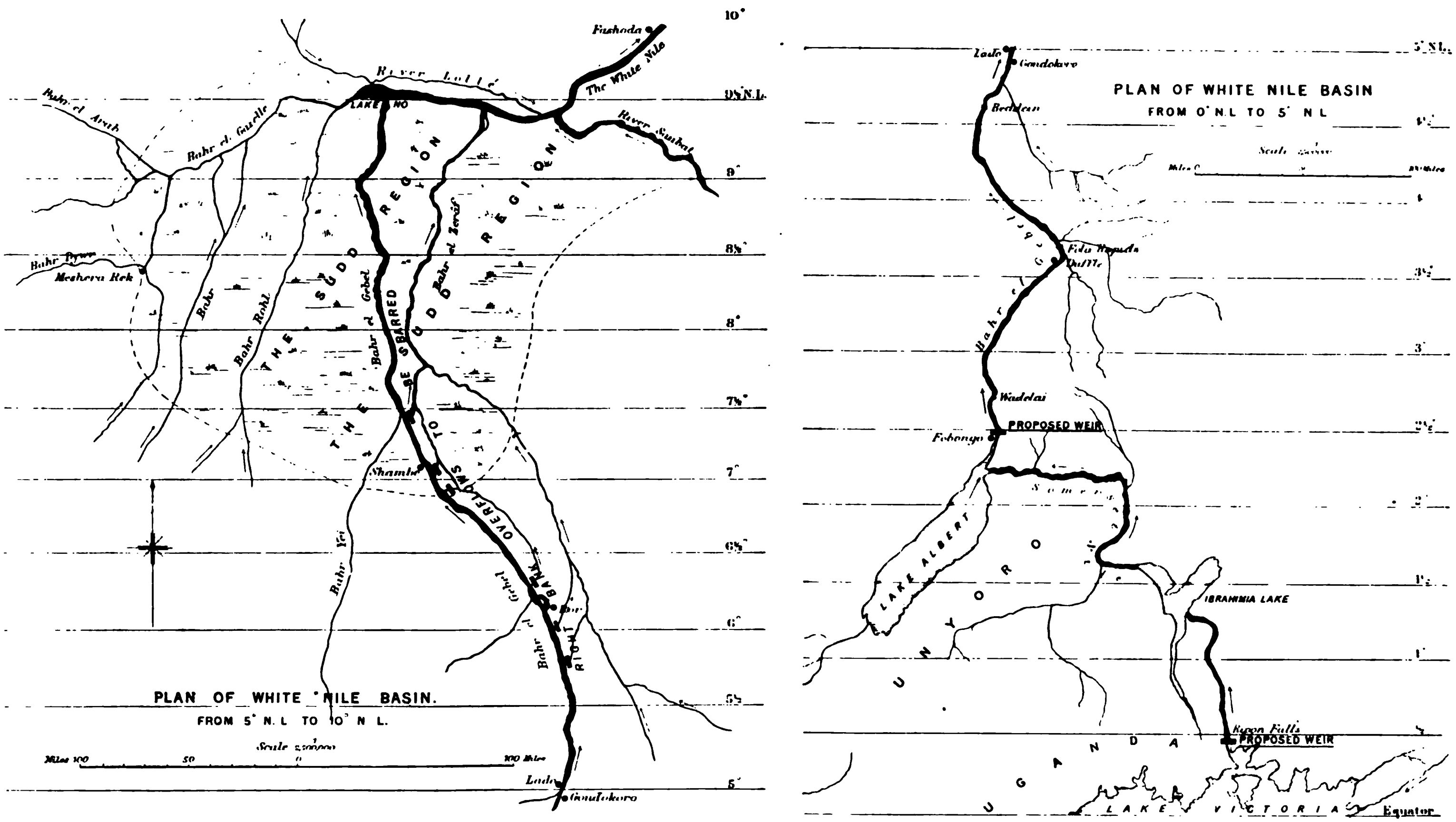
JOHN WARD, F.S.A.

Mr. John Ward is an authority not only on the antiquities of Egypt, but also upon those questions which make for the development of the country in modern times, and he has had exceptional opportunities of studying the irrigation problem. He shows the revolutionising effect of the dams which have already been constructed, and unfolds an important scheme for restoring to the Sudan the prosperity and prestige which it possessed in ancient times. A promising area for British engineering enterprise is here disclosed, and when the scheme has reached a more mature stage we hope to be able to arrange with Mr. Ward, who has lately returned to Egypt, for a further article on a subject which is largely bound up with the successful maintenance of our interests in the Nile Valley.—ED.

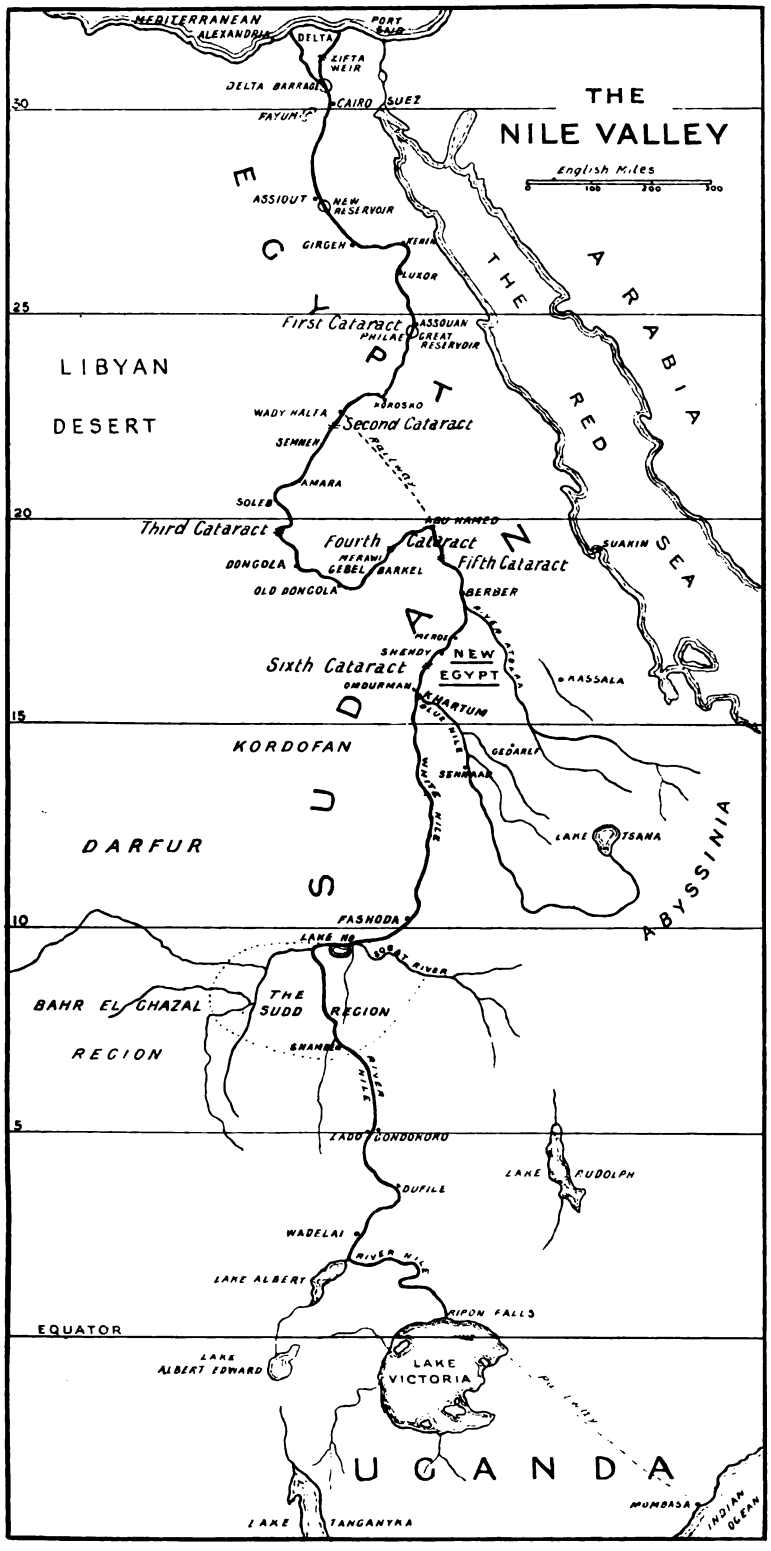
TWENTY years ago England found herself committed to the guardianship of Egypt. The empire founded by Mehemet Ali had been ruined by the reckless extravagance of Ismail. All other nations held aloof. Egypt seemed to have no friends left, as every available asset was mortgaged, apparently beyond hope of redemption. The French fleet, sent to protect the country in its dire necessity, sailed away. Our fleet, sent on a similar errand, remained at Alexandria, and saved Egypt from revolution. We have remained its Protectors ever since. In 1882, Lord Dufferin, being our Ambassador at Constantinople, was asked to visit Egypt and report. His advice mainly consisted in these points: "Establish an honest financial system; create a new army under British officers' training; bring trained engineers from India to introduce the system of irrigation, which has been so successful there. The Nile, under proper management, will bring in a sufficient revenue to meet all requirements." All this was carried out. The "Blue Books" of the time show how arduous was the undertaking; the results prove the wisdom of the advice. When the system of Perennial Irrigation is fully developed, two crops, and even three in some cases, will be possible. Forced labour is abolished, unless in cases of great emergency, such as the bursting of a canal bank. Water is the very life of Egypt. Formerly, the Pasha could divert all the irrigation to his own estates, if he pleased, and the fellah was taxed, whether he got the water or not. Now the peasant gets his supply equally with the Pasha, each in his regular turn.

All this is the work of the British engineer officers. The effect on the whole land is marvellous, the flocks and herds are doubled, the people are happy, better clad, are becoming rich, and are learning to use the savings banks, which have recently been established for their benefit. Schools are well attended, and all children, male and female, can now learn to read and write Arabic, and English if they so desire. Under all this it is no wonder that the returns of revenue are increasing by leaps and bounds.

Nobly have the small band of Britishers done their duty. Many have retired after active service; not a few died at their posts; these were replaced by men similarly trained. Sir William Garstin still leads the van of peaceful



SIR WILLIAM WILLCOCKS'S SUGGESTIONS FOR TRAINING THE WATERS OF THE UPPER NILE.



generals, Sir Colin Scott Moncrieff, Sir W. Willcocks, and Sir Hanbury Brown have retired from the service, receiving their well-earned titles for their eminent services. The veteran Lord Cromer still guides the destinies of the land, the wisest and kindest of rulers.

THE NEW DAMS AND THEIR EFFECT.

The vast reservoirs for perennial irrigation recently completed, caused the expenditure in labour of several millions sterling, of which the greater part was spent among the natives of of the country. At one time 20,000 men were at work. The mere fact of the new Dam at Assiout being completed a year before the contract time was the means of saving the whole cotton crop of Lower Egypt, valued at several millions sterling. The Nile "had forgotten to rise" in 1902, and had such a calamity occurred before the rule of the British Engineer, a famine would undoubtedly have resulted, with a loss of many thousand lives. Seed was supplied by the Government and all taxes remitted to those who suffered by the scarcity of water.

The income of the Egyptian Exchequer being assured, the enormous debt of the country, exceeding £100,000,000, is being gradually reduced, and its interest regularly paid as a matter of course.

FURTHER OPENINGS FOR BRITISH ENGINEERS.

In 1905 the debt is to be settled on a basis of sinking fund, which, it is expected, will *extinguish Egypt's entire debt* in fifty years. About the same time, the whole

FIG. 3. ZIFTA WEIR—RAYYAH ABBAS HEAD WORKS WITH CANAL LOCK.

One of the main features that the engineers had to keep in mind in constructing this barrage, was not only the irrigation of the land adjoining the Nile, but also the maintenance of an unobstructed waterway throughout the delta. At the extreme right may be seen a lock, through which vessels of considerable draught can pass all the year round.

revenue of the Suez Canal will fall absolutely into the hands of the Egyptian Government. This will be between three and four millions sterling per annum. Should Egypt require capital for the irrigation of the newly acquired Sudan Province, there can be no doubt that it has ample security for anything it may need, and, since the Sudan belongs jointly to the British Empire, the loan can probably be obtained at the same rate as if Great Britain were the borrower. Before perennial irrigation can be fully given to Egypt, further canals, weirs, and other engineering works in many parts of the country will be necessary. These, however, will all be within the powers and means of the ordinary staff of the Irrigation Department. Sir Hanbury Brown, late Chief of Irrigation of Lower Egypt, before his retirement from the service a few months ago, saw the completion of a very important undertaking, planned by himself, and entirely carried out by the ordinary staff. This is the greatest work ever so executed, and is of sufficient importance to be pictorially illustrated.

THE ZIFTA BARRAGE.

In order to assist in the distribution of water in the northern portions of the Delta, it was found necessary to construct a weir at Zifta, a point on the Damietta branch of the Nile, about half way between the Cairo Barrage and the sea. In the future the main canals which supply the Southern tracts of the Deltaic provinces will, as at present, obtain their supply of water from the river, upstream of the existing barrage, but the areas lying to the north will be supplied directly from the new Zifta weir. The advantages of this arrangement are obvious. The length of the existing canals is very great, and they traverse large tracts of highly cultivated country. It has been very difficult to force the water down to their northern reaches in sufficient quantity to give the lands dependent upon them their fair chance of water. With the completion of the new weir, or barrage, the lengths of the supply canals will be much reduced, and the distribution of water to the northern tracts will be greatly facilitated.

The Zifta Barrage was commenced in 1901. The total estimated cost of the work was £450,000, which includes a lock for navigation. It has actually been built for £320,000. The design is practically identical with the plan of the Assiout Barrage. The foundations at Zifta, as at Assiout, consist of a thick bed of concrete enclosed between cast iron "sheet piling." The weir consists of 50 openings of 5 metres each, with a lock of 13 metres in width. The total length of weir from bank to bank is 373 metres. It is planned to hold up 4 metres of water. (In summer water level upstream R.L. 7.30, downstream, 3.30.) The gates were, however made higher than originally designed, so that as much as 8 metres could be held up in case of a good supply, and in the summer of 1903 this was actually done. The soil of the river bed upon which the foundations were laid turned out to be far better than was expected, and this facilitated the work greatly. Great credit is given to Mr. Frederick Hurley, the resident engineer of the work, Sir W. Garstin, in his report, remarking that had it not been for his excellent arrangements, such a good out-turn of work would have been impossible.*

* Mr. Hurley is a native of Belfast. He was educated at Cooper's Hill College, and has been six years in Egypt.

The increased water supply, owing to this work, will repay the entire cost in a short time, in extending the area of cultivable land, as the taxes are levied on the crops actually produced.

The Great Reservoirs formed by the barrages at Assiout and Zifta have already had their powers tested in a remarkable manner. The Nile, from causes not yet fully understood, has often failed to rise to its ordinary summer flood. From the Bible record we find that the Low Niles of the days of the Patriarch Joseph lasted for seven years. Egypt has just recovered from four years of poor Niles, and in 1902 the river did not rise at all: it was the lowest Nile on record. The natives began to say "that 'Old Hapi' was so angry at the works of the British engineers that he would never rise again, and there would be no water to fill their dams." The dams, however, stored up so much of the ordinary Nile water that they saved the crops, though they were smaller, especially in districts remote from the river. Fortunately, the tide has turned, and the year 1903 witnessed a magnificent Nile flood. The great dams have thus shown their value during the lowest Nile on record, and that they are fully capable of dealing with normal risings.

THE WORK OF THE DAM AT ASSOUAN RECORDED PICTORIALLY.

In this respect it will be interesting to record pictorially the aspect of the Great Dam at Assouan, in the winter of 1902-3, the first occasion of its being filled to summit level. This was after the memorable summer, when the Nile did not rise at all, and yet the reservoir is full—too full for the unfortunate Island of Philæ. The photographs show it entirely under water, and only its temples, colonnades, and pylons peer above the deluge. The ancient Nilometer is swallowed up: the waters are high above the floor of Nectanebo's temple. The Kiosque (built for a proposed visit of Augustus that was never realised) still shows its unrivalled elegance of design—Egyptian architecture enriched by classic taste.

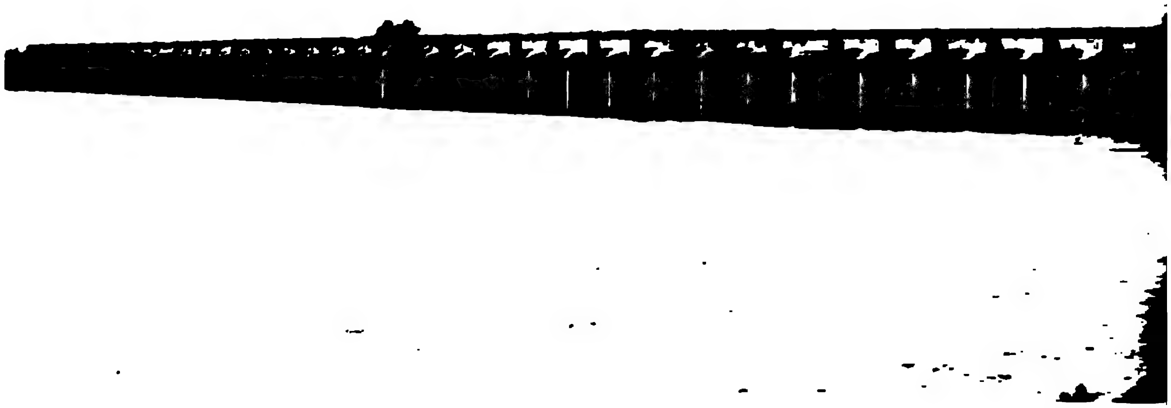
SELECTION OF THE ASSOUAN SITE.

The stored-up water, at a time when the Nile flow had been lower than ever recorded, is a triumph of engineering skill. But the illustrations may have a depressing effect on the mind, and an artist or archæologist may regret that Sir William Willcocks did not put the Dam a few miles further south. He, engineer-like, honestly chose the place best suited for his granite wall, where half of it was already made of the living granite rock. But when the Assiout Dam was built (on the river's bottom, actually on the Nile mud), was a granite foundation so necessary here? Well, we need not complain now: it is too late.

Sir Benjamin Baker also selected the same place, after Sir W. Willcocks had left the Government service. Sir B. Baker offered to re-erect every building, every stone of the temples on the adjacent Island of Biggeh (from which our

Ptolemaic Temple. Pharaoh's Bed.

FIG. 5. THE ASSOUAN RESERVOIR—VIEW AT SUMMIT LEVEL, WINTER OF 1902-3.
Showing the general view of the submerged Island, looking south.



ZIFTA BARRAGE—RAYYAH ABBAS HEAD FROM

This Barrage, entirely constructed by the Egyptian Irrigation Department, with native labour, has not been previously

views are taken), but his offer was treated with derision by antiquaries.

It is only fair to Sir William Willcocks to state that he suggested various other sites for his dams as well as this one, and that he was not in the employment of the Irrigation Department when the work was decided on. The entire scheme for reservoirs which Willcocks had been employed to design, had been laid aside, and, thinking that he was no longer needed, he accepted other employment. Unexpectedly, Sir Ernest Cassel came forward with the funds, and Sir John Aird offered to make the dams. These offers were accepted, and it thus happened that other hands than the inventor's carried out the work. The author has his own private opinion of the merits and demerits of the case, but at present he is relating only the story of the great works of the irrigation engineers, and it is better to keep to the utilitarian side of the question, and from that point of view alone, everyone must admit that it is the greatest construction of the kind that the world ever saw, and that it admirably performs its work.

INCIDENTAL SACRIFICES.

It is to be feared that when a few seasons pass, all the palm-trees, of which we now see only the tops in the photographs, will have perished. There was one shady plantation of fertile date-palms on the right bank of the old Nile, whose tops are now only seen above

ZIFTA BARRAGE—VIEW FROM RAYYAH

EAST BANK OF THE NILE, LOOKING UP STREAM.

illustrated. It is the greatest work of the kind yet undertaken and carried out, within the resources of the Department.

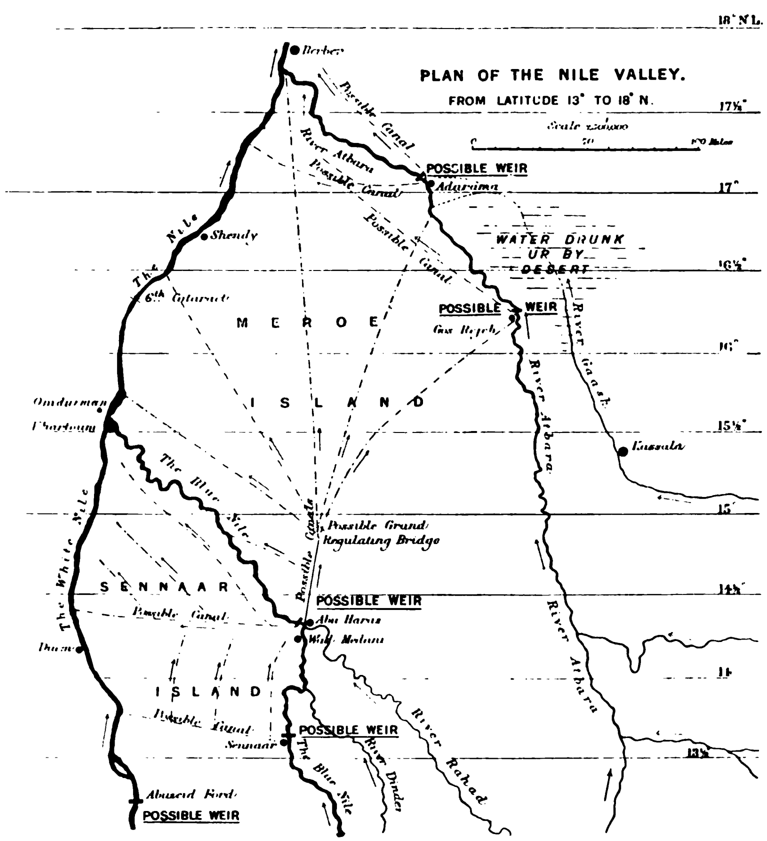
the waters. A few years ago these palms sheltered a tiny cottage, in which the writer lived for many weeks, employing his days in studying and recording with pen and pencil the beauties of the island and its interesting monuments, knowing that their fate was sealed. The cottage, with its pretty garden, is now overwhelmed. The most picturesque district in Egypt was doomed to disappear before the all-powerful engineer.

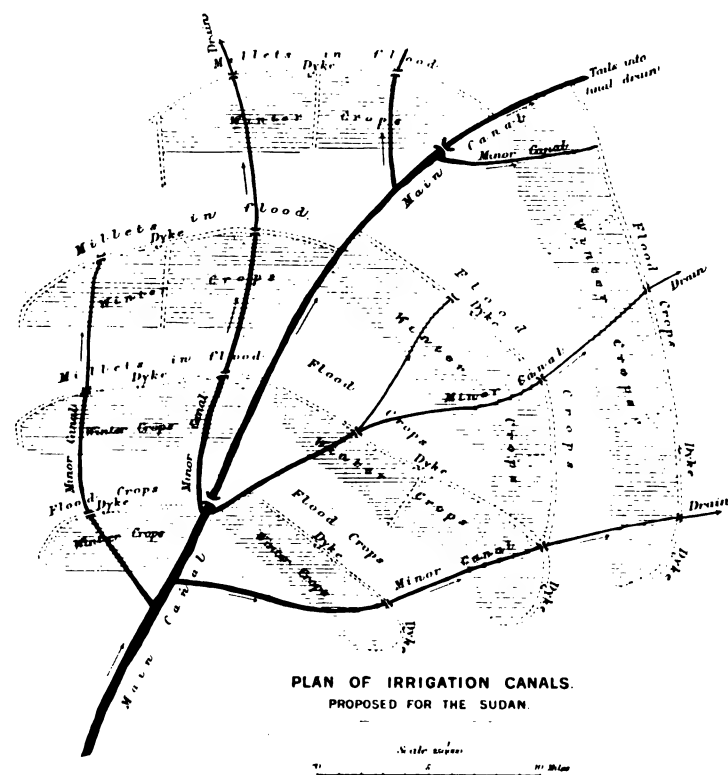
The beautiful island and its surroundings, however, have perished in a good cause! It is to be feared that some of the ancient temples on the Nile bank between Philæ and Wady Halfa will also be submerged by the waters of the great Dam. The narrow strip of cultivable land along the Nile in Nubia will have disappeared in many places. Compensation, however, has been given, or good land elsewhere, allotted to the inhabitants by the Government.

THE DAIRA SANIEH ADMINISTRATION.

In Ismail's time and previously, much of the best land at many points between Cairo and Assouan had been forcibly seized by the State and converted into sugar and other estates. The unfortunate people who had owned the land for generations were driven off without compensation, themselves and their families ruined. On these great estates—known as the Daira Sanieh—comprising the best land in Egypt—Ismail had borrowed many millions sterling.

ABBAS HEAD, LOOKING DOWN STREAM.





SIR WILLIAM WILLCOCKS'S SUGGESTIONS FOR IRRIGATING HIS "NEW EGYPT."

As the present Government of Egypt undertook the liability of the payment of the interest, these lands became an asset which they could dispose of as seemed best for the interests of Egypt. In 1898 Lord Cromer concluded an arrangement with a group of financiers for the sale of all the properties, known as the Daira Sanieh Administration, for a price amounting to the sum of the Daira Sanieh Loan. The purchasing company undertook to re-sell the property under certain conditions in a certain number of years, the half of the profits to belong to the Government. This vast, unwieldy property is now successfully worked by private individuals, and will bring in a large gain to the Egyptian Government, much more than could have been obtained by official management.

EGYPT FIFTY YEARS HENCE.

Sir William Willcocks has been for some years manager of these vast estates. But he has not given up his deep interest in his own profession of an irrigation engineer, and frequently writes and lectures on the subject. One of his most remarkable lectures—"Egypt Fifty Years Hence"—was recently given in Cairo. In this lecture, which has been printed for private circulation, he enlarges on the results of the completion of the system of perennial irrigation, and describes the development of canals, weirs, escapes, and pumps, that will gradually bring the area of cultivated land up to what it was in the days of the Romans, when vast spaces, now desert and barren, were under cultivation. Egypt was then the granary of Rome, besides supporting double its present population. In far earlier ages Egypt must have been densely peopled. All over the country one finds immense black mounds of rubbish, the sites of lost cities deserted 3,000 years ago. Many of these are in the now barren desert. Sir William Willcocks would give them water again, restore the country's fertility, and by spreading the black rubbish over the land by means of light railways, would fertilise it. Strange to say, the rubbish heaps make the best of manure, being nearly all composed of old decayed mud bricks, mixed with organic matter.

PROPOSED IRRIGATION OF THE SUDAN.

But the most interesting portion of Sir William Willcocks's address referred to his suggestions for the proposed irrigation of the Sudan. He explains that the circumstances of the Sudan are quite different from those of Egypt. The Nile in the new provinces flows in a deep trough, and does not overflow its banks as in the North. The system of irrigation must be quite different from that of Egypt, and more like the plan pursued in India.

In Egypt the Nile has no tributary streams, and the land is rainless. In the Sudan there are two considerable rivers falling into the Nile, which rise in the Abyssinian mountains, and there is a rainy season in the neighbourhood of Khartoum and beyond. From Assouan to Khartoum the Nile traverses pure deserts in a clearly defined channel of 1,150 miles without any loss beyond that of evaporation.* Willcocks says that that Nile is fed by percolations from springs along its course, and that the losses by evaporation in summer are fully met by these springs.

The mean discharge of the river in Nubia is 100,000 cubic feet per second—the maximum being 475,000 cubic feet, and the minimum 7,000 cubic feet, per second. It is this great margin of wasted flood that suggested the formation of the New Nile Reservoirs.

There are ruins of great cities all along the river banks, from the Second Cataract to Abu Hamed. The district is now almost deserted, save for the poor towns of Dongola and Merawi and some wretched villages. In ancient times this region supported an enormous population under powerful kings, and gave a dynasty to Egypt. It is now deserted and barren, but irrigation can restore its fertility. The Third and Fourth Cataracts can be exploited to provide supplies by the erection of weirs, and locks for navigation would form a part of them. Beyond Abu Hamed the Fifth Cataract could be similarly made use of, and irrigation supplied all the year round. At Berber we approach the rainy district, and hence will be in a couple of years the railway communication with Suakin and the Red Sea, now in progress, from which Lord Cromer expects so much.

THE NEW EGYPT.

We now enter the ancient Kingdom of Meroe—a populous region down to Roman times. There are vast ruins of cities, pyramids, and temples. The irrigation canals and reservoirs which gave them life can still be traced. The mountain streams were once dammed up in the rainy season, and all the land was richly cultivated. Now it is a wilderness, deserted save by wild animals, though there are still a few villages, and partial cultivation is in progress. The Atbara pours into the Nile here, the first

* At the Second Cataract, however, there seems to be a wide expanse of waste, which could be easily converted into a reservoir by a weir, and would undoubtedly be of great service to Nubia.

contributory river to "Old Hapi," who has to pursue his unaided rainless course all the way to the Mediterranean.

Between the Atbara and Khartoum the land was known in classic times as the Isle of Meroe. No doubt in those days it was richly cultivated, and teemed with population, flocks, and herds. Now it is depopulated save by gazelle, deer, and other game. The country is covered with mimosas, stunted trees, and prickly shrubs. Poisonous "apples of Sodom" and many wild flowers flourish. All this growth is fed by the copious rains of autumn, and were the waters stored up for irrigation as in olden days, there would be good crops, given the population necessary to cultivate the land. Here Sir William Willcocks places his "New Egypt," which he prophesies will extend as far as Sennaar.

At Khartoum another fine Abyssinian river joins the Blue Nile. (The main stream from its colour is called the White Nile.) This well-watered corner of the Sudan delights the enthusiastic Apostle of Irrigation. He waxes eloquent over his fancy-picture of the derelict plains of Meroe and Sennaar being revolutionised like the Punjab. Thirty years ago, he tells us, the sandy plains of the Punjab supported a miserable scanty population, which depended on a poor and fitful rainfall for a precarious existence. To-day these same plains are covered with millions of acres of cereals and teeming villages depending on the flush irrigation from the great canals constructed by the Indian Government. He prophesies that the Meroe and Sennaar Peninsulas will be traversed by perennial canals, and will become the most prosperous regions in the world, producing quantities of cotton (so much needed in Lancashire now), cereals, and green crops.* Sir William Willcocks says "a rich soil endowed with flush irrigation will be attracting hundred of thousands of Egyptians from the densely packed provinces of Keneh and Girgeh, who will be converting those desolate plains into smiling fields."

To-day it seems hopeless to get a single *bonâ fide* immigrant to the desolated land, but Sir William Willcocks is no visionary, his work in Old Egypt is a guarantee of the wisdom of his counsel. Certainly, anyone who has visited New Khartoum and seen its beautiful Palace Gardens will admit what irrigation can do in such circumstances. The sooner a beginning is made to do something for the irrigation of the Sudan the better, for the country as it is, is a heavy charge on Egypt. Meantime, the great obstacle is the absence of population, owing to the disastrous effects of the Khalifa's cruelty, and the raids of slave-dealers.

NEED FOR AN IMMEDIATE IRRIGATION SURVEY.

Since the conquest by Lord Kitchener, the authorities have not been idle. Lord Cromer himself voyaged by the Nile as far as Gondokoro recently, wishing to see for himself the passage

* Egypt is likely to become one of the great sources of cotton-supply for Great Britain. Specimens of cotton grown in the Sudan have recently been pronounced by experts to be in every way superior in quality to Egyptian cotton.

FIG. 7. THE ASSOUAN RESERVOIR—VIEW AT SUMMIT LEVEL, WINTER OF 1902-3.
Showing the submerged Temples of Philæ and the Kiosque of Augustus ("Pharaoh's Bed"), looking west.

through the "Sudd" (which Major Peake and other heroes had cut* to free the Nile's course), and generally to study the question on the spot. Sir William Garstin, who may be described as Lord Cromer's right-hand man, has lately returned from an arduous journey from Cairo by Suez and the Red Sea to Mombasa and Uganda. Thence he took the British railway and steamers to the Lakes Victoria and Albert, and descended the Nile by Wadelai and Lado, through the entire Sudd region to Fashoda by the Blue Nile to Khartoum. This wonderful journey, by a man who had only recently recovered from an attack of illness, deserves our admiration. It may be safely anticipated that the outcome will be a serious inquiry into the whole question of saving the Sudan from debt and penury by the means of a great irrigation scheme. We have shown that the Egyptian Government will soon be in a position to find the money for such an enterprise. Sir William Willcocks was given three years to survey and report on the great Reservoir question in Egypt. He is not now available, but there are good men in Egypt, quite fit for undertaking an irrigation survey of the Sudan, and it should be done at once.

Sir William Willcocks suggests the formation of great works at the outlet of the Nile from the Central Lakes, to raise their level. He also has a plan of his own for permanently keeping open a channel through the Sudd, and other extensive works on the White Nile. Lord Cromer, however, wisely counsels these costly works beyond Khartoum being delayed for the present until the whole Nile Valley has been surveyed, and the mysteries of the great river's vagaries are fully understood.

The clearing of the Sudd has left the passage for steamers free to the great Lakes. The River Nile has returned to its good old ways, the high Nile of 1903 being one of the best, and these costly works can wait. In the meantime, the irrigation of the region which Sir William Willcocks calls "New Egypt" does not involve any gigantic engineering works at the White Nile or at Lake Victoria.

It merely manipulates the River Atbara and the Blue Nile, and could be proceeded with. But the survey must be undertaken first.

* Fortunately for Egypt the Kalifa was annihilated in November, 1899. Within a month of the final victory Sir Reginald Wingate had started an expedition under Major Peake, R.E., to remove the Sudd, which blocked the Nile between the 7th and 10th parallels of latitude in the Bahr el Gebel. The expedition consisted of four or five gunboats under two Naval officers and some thousand convicts. This work cost £15,000, and the water liberated was of sufficient quantity to save Egypt from drought, and made a present to the country of an increase in the crop of cotton valued at £4,000,000.

FINANCE.

Sir William Willcocks estimates the cost of the project for irrigating the Island of Meroe from the Atbara to Blue Nile at some £10,000,000. The land when irrigated would be worth £20 per acre, and two million of acres now barren would be irrigated. It is a healthy district of the Sudan, and could easily produce two crops every year. From the return we have already seen from the Willcocks dams in Egypt, there seems no reason to doubt the accuracy of the figures. Regarding the millions required for the Nile reservoirs now completed, Sir Ernest Cassel and his friends found the capital when the "Caisse de la Dette" refused it, although they had a large reserve saved by Lord Cromer's management. As money was supplied for the great Reservoirs by outside capitalists, no doubt the necessary funds could be also so obtained for the Sudan, should the Government shrink from raising the money themselves.

The great question is the want of population. Sir William Willcocks knows the Egyptian fellaheen intimately, and he believes they will be quite willing to colonise his "New Egypt" when it is made fertile by irrigation. He shrewdly points out that the present annual loss to Egypt by the Sudan is some £400,000, which, capitalised, amounts to £10,000,000. He believes that a proper system of irrigation for the Sudan will wipe out all this loss, bring in, in a few years, an enormous profit, and secure Egypt from famine and from floods for all time.

CONCLUSION.

We can rely on Sir William Willcocks; we know him by his works, and on such matters his advice should be followed as soon as Lord Cromer sees his way to do it. The matter may safely be left in Lord Cromer's hands. No pro-Consul was ever more astute, more tactful, more just. A born diplomatist, he has cut the Gordian knot of Egyptian finance, and has settled the question to the satisfaction of the interested Powers and their subjects. In devoting his life to the regeneration of Egypt, he has added a new glory to the British name as the protector of the weak, the only nation that is the determined enemy of slavery. And Lord Cromer's great work in Egypt is not yet complete. Long may he be spared to carry on his beneficent rule in the Land of the Nile! His modest official title is "British Consul-General," but he is to-day the virtual ruler of Egypt, and sways the destinies of the most ancient community in the world.

NEW DIVING TORPEDO BOATS.

By HERBERT C. FYFE.

A1,—THE largest submarine boat yet built for the British Navy, arrived at Portsmouth a few weeks ago, and is now being submitted to a series of exhaustive trials.

The Navy Estimates for 1901-2 provided for five submarines of the *Holland* type. These boats, "Nos. 1-5," are very similar to the newest American submarines of the *Adder* type. The Navy Estimates for 1902-1903 provided for four submarine boats of a new and improved type. These are known as *A*1, *A*2, *A*3, *A*4. All nine vessels have been built by Messrs. Vickers, Sons, and Maxim, at Barrow.

The Navy Estimates for 1903-1904 provided for ten further diving torpedo-boats, and an order for these has just been placed by the Admiralty with the above-mentioned firm. They will be known as *B*1, *B*2, *B*3, *B*4, *B*5, *B*6, *B*7, *B*8, *B*9, *B*10, and will be the biggest submarines in the Royal Navy.

It may be interesting to compare the first five boats with the four newer craft. The details of Nos. 1—5 are as follow: Length, 63 ft. 4 in.; beam, 11 ft. 9 in.; displacement (submerged), 120 tons; surface motor, 160-h.p. gasoline engine; sub-surface motor, 70-h.p. electric motor; speed on surface, 8 knots; speed below surface, 7 knots.

The *A*1-*A*4 class have a length of 100 feet; beam, 20 ft. displacement (submerged), 200 tons; surface motor, 200 h.p. petrol engine; sub surface motor, 70 h.p. electric motor; speed on surface, 15 knots; and below surface, 10 knots.

Considerable difficulty has been experienced in driving *A*1—the only one of its class which has up till now been put on trial—below the water. In the "awash" condition, *i.e.*, with ballast tanks full and only her conning tower showing above the water, she is driven under the waves by her pair of horizontal rudders at the stern. Nos. 1-5, all now at Portsmouth, behave very well in this respect; they disappear quickly beneath the surface, and can be brought up again equally speedily when the commander wishes to take his bearings from his position in the conning tower. It is, of course, essential that a diving torpedo-boat should be able to dive and rise in a few seconds, for, in spite of periscopes and optical tubes, it will still be necessary in an attack to come to the surface every now and then to take note of the enemy's position. Unless the submarine disappears again before many seconds have elapsed she will be exposed to the terrific fire that will be poured upon her by the quick-firing guns of hostile ships, and will stand a good chance of being sent to the bottom by the fleet torpedo-boat destroyer, armed with its explosive boom.

The general opinion seems to be that the chief reason why it is so difficult to submerge *A*1 is the fact that she has not sufficient horse-power. Her petrol engine is not sufficiently powerful to effect her submersion, and it is stated that the mechanical arrangements for assisting in the submerging of the vessel do not work with efficiency. Possibly, if fitted with side rudders, as are the French *Gustave Zédé* and the American *Protector* (*Lake* type), *A*1 might be made to submerge more rapidly than she does at present. The British submarine No. 5 is shown in the accompanying illustration, and forms an interesting contrast with the new Russian submarine illustrated below.

THE NEW RUSSIAN SUBMARINE BOAT, THE "PERR KOCHKA."

BRITISH SUBMARINE NO. 5 AT PORTSMOUTH.

OUR MONTHLY BIOGRAPHY.

SIR WILLIAM EDMUND GARSTIN, K.C.M.G.

SIR WILLIAM EDMUND GARSTIN, nominally "Under Secretary of State for Public Works in Egypt"—really the acting Prime Minister of Egypt—is a remarkable man. He was trained to irrigation engineering in India, where he rapidly rose to notice. He was one of that intrepid band of young engineers, who, by Lord Dufferin's advice, were sent to reorganise and develop the resources of Egypt. He first saw Egypt in 1885, and in 1892 was appointed Inspector-General of Irrigation. But his duties extended far beyond that of controlling the irrigation, and in everything he has been called upon to do, he has shown his rare talent, tact, and power. Born, like his former coadjutor, Sir William Willcocks, in India, he was well fitted for work in a tropical country, and his mastery of the Arabic tongue makes him popular with the crowd of native officials and employés of the Government Services.

Lord Cromer has had his help in many delicate arrangements, such as readjustment of taxation and the revaluation of the cultivated land, and he has had several diplomatic missions. He has undertaken many tours of inspection to the distant provinces.

Sir W. Garstin recently made a remarkable journey by way of the Red Sea to Mombasa. Thence he made a tour in Uganda and to the Abyssinian frontier, the White and the Blue Niles, the Great Victoria Lake, and other waters of Central Africa, returning to Egypt by Gondokoro, Lado, Wadilai, Fashoda, Lake No, and through the entire Sudd region of the Bahr el Gebel and the Bahr el Ghazel. The cutting of channels through the Sudd is especially of his planning, and Major Peake and other officers employed on that arduous undertaking acted under his direction.

Sir W. Garstin is Lord Cromer's right hand man. He is always ready for any difficult job, either in engineering or any other branch of the service. The amount of work he is capable of is extraordinary. His despatch to Lord Cromer in 1901, with a report as to irrigation projects on the Upper Nile, with the graphic description of his wonderful expedition through the poisonou: Nile swamps, reads like romance. Being onl published as a Blue Book (Egypt, No. 2, 1901 it has not much chance of being seen by th general public.

SIR WILLIAM EDMUND GARSTIN, K.C.M.G.

One of His Majesty's Under Secretaries of State for Public Works i Egypt. Grand Cordon Medjidie, Second Class Osmanieh, etc., etc

His last journey (1903) by the Red Sea Mombasa, and through Uganda and La Victoria to Khartoum, was his crowning fe of exploration. The report of this gre expedition has not yet been published, but looked for with much interest.

Sir W. Garstin takes a great interest in t antiquities of Egypt, and is one of the co: mittee for the control of their exploration a: conservation.

How to Educate an Electrical Engineer.

BY

E. KILBURN SCOTT, M.I.E.E., A.M.Inst.C.E.

In response to a number of inquiries, and believing that a paper on this subject by a practical member of the electrical engineering profession will be useful to students, parents, and guardians, we asked Mr. Kilburn Scott to undertake the following article. In addition to a careful outline of the training necessary, the writer deals with various pit-falls to be avoided by the embryo electrical engineer.—Ed.

"I SHOULD be pleased if you could inform me where you consider the best place to educate a boy for electrical engineering, and at what age he should start."

Every engineer is constantly receiving such communications, and finds them somewhat embarrassing, because (fortunately), human nature cannot be deduced to a system or a formula, and therefore what is good advice for one boy is not necessarily the best for another. There are also many branches of electrical engineering—thus, electric light and power, electric traction, electro chemistry and metallurgy, besides other branches — telegraphy, telephony, wiring and fitting—these latter, however, are not so much an engineer's as an electrician's job. Hitherto there has been far too much electrician and too little of the engineer in the profession. After all, wiring is nothing more or less than glorified plumbing; an electric joint does not require nearly so much skill as making a wiped joint to a lead pipe.

The writer will assume that the inquiry refers to electrical engineering, with the stress on the word "engineering."

CHARACTER AND TACT.

Before everything else a boy requires character and tact, for the engineering profession is one which carries its members into every part of the world, and they are constantly called upon to direct affairs and set an example socially as well as technically. After all is said and done, the great feature of English life is the home training, and it is in the early years and especially just before entering into the business of life that character is formed.

If, therefore, by staying a little longer at home or at school a boy is thrown into contact with those having high ideals, then the purely technical training may well be deferred another year or so. If the boy is to attain any position at all, he will need to be a *leader of men*, and in some cases on a considerable scale. Initiative and decision of character are therefore essential.

PHYSIQUE.

The parents who start a boy in engineering having poor physique or poor health are much to blame, because the profession is essentially one which calls for a robust constitution. To get to work at six in the morning, and keep at hard manual labour all day, amongst noisy machine tools, is in itself a considerable strain, but this is not all. When home in the evening he must study text-books, attend evening classes (in moderation), study the technical journals, etc., or he will "get left."

Independently of this, however, sound physique and a good address go a very long way when the commercial side of the business is reached. The writer is of opinion that military training is necessary, and, if the boy has not been in the school cadet corps, he should join the volunteers, (if in London the electrical engineers) as soon as he is old enough. It should be remembered that the success of the Germans is as much due to the qualities brought out by their military training as it is to their great facilities in technical education.

EARLY EDUCATION.

A liberal education is essential, and its aim should not be so much to fill the boy's head with knowledge, as to make him quick to assimilate *special knowledge afterwards*; in other words, to teach the boy how to learn. If, whilst at school, he is able to take up some handicraft, such as carpentry, it will be as well, for, when he goes into a regular workshop, and the men see that he can already handle tools, they will respect him all the more.

In the school curriculum mathematics and French or German should take precedence of Latin or Greek, but the writer does not say the latter should be omitted. As a matter of fact, Latin is most useful in the assimilation of modern languages, especially as the boy may in after life have to learn Spanish or Italian. Freehand and geometrical drawing are necessary for accurate and rapid sketching, but the designing engineer of to-day must also be something of an artist, and train his imagination. Some of the cleverest engineers are most artistic.

Coming to science, the only two subjects which a boy need trouble with at school are chemistry and physics. These can be easily learnt whilst at school, and chemistry especially, is useful in every walk of life. In electrical engineering it is particularly helpful because of the great developments which are taking place in electro chemistry and metallurgy; in fact, there is more scope in this branch than in either electric lighting or electric traction.

We will now suppose the boy is sixteen years old. The next step is to get him into some small mechanical engineering workshop, for the parent must remember that electrical *engineering* is essentially mechanical. When one considers that in a central station 75 per cent. of the machinery consists of boilers, engines, condensers, pumps, water softeners, piping, valves, and that the design of a dynamo machine is practically a piece of mechanical engineering design, it will be seen how important it is that the purely mechanical training should take precedence.

PREMIUMS.

It would, perhaps, be well at this stage to say something regarding the payment of premiums.

If it can possibly be managed, it is best not to pay a premium for a boy to learn shop work, *i.e.*, fitting, turning, etc.; it is much better for him to go as an ordinary apprentice, and keep the regular shop hours. There will be more use for the money later on in giving him a sound college education, or with some leading consulting engineer, or possibly starting him in business. Paying a premium to an individual in *private practice* is a different matter from paying it to a company, where it merely goes to swell dividends, and there is usually no obligation on any individual's part to see that the boy gets value for the money.

There are, of course, exceptions. Some engineering firms having a well-thought-out system of training their young men, and in some cases engage an engineer specially to look after them, and deliver lectures, etc. One North of England firm the writer knows divide their apprentices into three classes, and have the following regulations —

1st Class.—Apprentices can keep their own time; can be moved from one shop to another as they desire, and finish their education in the drawing office. Term of engagement not less than three years. Premium, £120 per annum, paid in advance.

2nd Class.—Apprentices to keep the regular hours of the shop, failing which they render themselves liable to be discharged without notice, and forfeit the premium paid. They will be removed from one shop to another when the company considers them fit for the change, and will be put in drawing office should they be considered suitable. Term of engagement, three years. Premium, £80 per annum, paid in advance.

3rd Class.—Apprentices to keep shop hours as in second class. They will only be removed to another department as it suits the company, and will not be taken into the drawing office. Term of engagement, three years. Premium, £50 per annum paid in advance.

That a premium is not absolutely necessary is shown by the fact that the writer was with this same firm sixteen years ago, and went through their fitting and erecting shops, worked at the lathe, and also spent some time in the drawing office. During all the time he was employed as an ordinary hand, keeping the usual hours, and receiving a fair weekly wage, besides sharing in the piece money when any was made. At that time the firm took premium pupils, but they did not appear to have any special advantages. Perhaps things are a little different now, as the firm has been bombarded with applications for boys to enter their works.

A POINT TO BE WATCHED.

An important matter, which should be watched carefully is that several technical schools, or so-called colleges, make a pretence of giving their students a complete practical, as well as theoretical, training. It is hardly necessary to say that this is the greatest nonsense, for practical work *must be learnt in an actual works* to be of any use.

If the youth goes to a college at all, it should be to one of the very best, because the engineer who is to take a leading position requires breadth of thought, originality of method, and acquaintance with the world at large rather than to merely fill the brain with ill-assorted or half-digested information. It is for this reason that the all-round well-educated man is better fitted to conduct an important business concern than is the ill-trained product of a cheap technical school.

The writer is entirely against sending a student to college before he has been in a works, because he may attach too much importance to pure theory and too little to practice, whilst some college students are apt to sneer at dirty work, and this causes them to be disliked by the workmen, who are, after all, their teachers for the time being. A working mechanic is the last person in the world to give a young man any information if the latter puts on "side."

THE SMALL WORKSHOP.

A search through the biographies of those who take any important position in the profession will show that a large proportion were originally trained as mechanical engineers in *small* shops, and that they afterwards *drifted* into electrical engineering work.

The question therefore resolves itself into how best to pick up the necessary mechanical experience and afterwards the additional electrical knowledge, both theoretical and practical. One great advantage in going into a small shop first is that there is generally a *local concern* where one can get a start, and the boy is thus kept in touch with his home. This is important, because life in lodgings, away from all social intercourse with relations and friends, is not a good thing for a young man still in his teens.

In small shops a sharp boy soon learns to use most of the machine tools, drilling, planing, shaping, and the lathe, besides drawing down and tempering his own chisels, etc. He may also have to tend the engine and boiler, and, in fact, do all kinds of odd jobs. Outside repair work amongst various classes of machinery is also a most valuable experience; in fact, the more millwrighting in character the shop is, the better the training.

The writer was for two-and half years in the oldest established millwrights' shop in the country, and the *general experience* gained whilst working out in various North of England textile factories, leatherworks, etc., has been valuable. For any one going to the Colonies it is excellent training.

If possible, the embryo electrical engineer should enter as an ordinary lad, starting at six o'clock in the morning, and receiving a wage of 5s. a week to commence, rising, say, 2s. 6d. a year. These are small wages, but it is a mistake to be in too great a hurry to earn money, as it may handicap the learner by keeping him too long at one job. The boy must always keep well in mind the fact that he is not going to *remain a mechanic*, but is in the shops merely as a steppingstone to something higher.

In such a shop as the above there is generally a certain amount of pattern-making, packing case making, etc., and the school carpentry work will come in handy for this. If there is a brass or iron foundry, try and get a little time in these, for it is in the pattern shop and foundry that one acquires that special knowledge necessary to become a trustworthy and *economical* designer. It is quite impossible, and, in fact, unnecessary for the youth to become a skilled workman at any of the above-mentioned trades, but he will pick up enough to see how the work *should be done* and to be able to detect any shoddy work or malingering when he attains a position of responsibility, and has men under him.

In this connection it is well to remark that the young man should take every opportunity to become intimately acquainted with the men, without being too familiar. He should become acquainted with the men's aspirations and ideas of fair treatment, and the organisation and inner working of their unions, for the successful master of *the future* will require to be on

good terms with and in sympathy with his employés. There are all sorts of little matters, such as various systems of paying by piecework, which the youth may be puzzled with at first, but which he soon becomes conversant with, particularly if it affects his own pocket. A useful boy may also be called in to do odd jobs in the office, such as making a tracing, going round to pay accounts, reporting upon a breakdown, etc.

Sometimes, where there is no premium or indentures entered into, there is danger of the youth being kept at one job, say the shaping machine or lathe, too long, for, naturally, there is a temptation to keep him at work which he already knows. To check this the boy should report at regular intervals to his parents or some friend as to the kind of work he is engaged upon. If there is any sign of being kept too long at one job, a little backsheeh to the foreman or leading hand will generally rectify matters. The writer's experience is that it is not wise to go to the principal of the firm if it can be avoided. He is usually a busy man, with more important things to look after, and, besides, the foremen are apt to resent it.

EVENING CLASSES.

Whilst he is going through the shops the youth must systematically attend evening classes in machine drawing, practical, plane, and solid geometry, applied mechanics, and steam under the Science and Art Department; and also, later on, mechanical engineering and electrical engineering, if there are classes for these subjects, for the City Guilds' certificates are worth having. If he has been well grounded in chemistry, physics, and mathematics at school, he will not now have to trouble about these, but metallurgy and iron and steel manufacture are good subjects to study. He must make a point of understanding the value of curve plotting, and he cannot do better than thoroughly master Professor Perry's most excellent lectures in "Practical Mathematics," published by the Science and Art Department.

It may be mentioned that the student who wishes to become an engineer must not carry his thoughts too far into the regions of pure science and higher mathematics, for an engineer learns much from *approximations*, which the pure scientist or the mathematician would consider hopeless. A knowledge of the differential calculus is useful, but is certainly not absolutely necessary. It is necessary, however, to become thoroughly expert in the manipulation of the slide rule, for in the drawing office or estimating departments, it is so useful for working out quantities, weights, costs, etc. It is quite a common thing to see foremen using the slide rule in Swiss and German electrical works, which reminds the writer that he has often seen those clever old millwrights, who unfortunately are becoming now so scarce, making calculations with the brass slide in an ordinary two-foot rule. The slide rule, by the way, is now admitted at most of the technical examinations in the subjects mentioned above, and is a very great help.

In case the youth is so situated that there is no large town where evening classes can be attended, then he must pick up his theoretical knowledge by systematic reading of text-books with some older friend to guide him, or there is another course, namely, entering his name with one of the correspondence schools. The best of these schools have their headquarters in the States, and it is really remarkable how much information may be acquired in this way. The writer has known several young men who have benefited considerably. It is only fair to mention that in connection with technical work the correspondence system is not improperly used for the purpose of *cramming for degrees*.

COLLEGE TRAINING.

Having completed his two or three years in the small shop, we now come to a point where the future depends on the financial status of the parents. The writer had to depend for his theoretical knowledge on evening classes, but he knows well the limitations of that method, and is of opinion that money spent in giving a youth a full engineering course in a first class college is well spent. In the old days it did not so much matter, but nowadays high scientific requirements are necessary if the youth aspires for a leading position in the profession. Others set the pace, and he must follow or "get left." The crowded technical colleges in America and on the Continent, all equipped in the most complete manner, testify to the great change which has taken place in ideas of engineering education. So much is the college graduate appreciated by engineers in America, that often, before they leave, the brighter students are offered good situations.

In England college fees are higher than in the States or on the Continent, and parents may well consider whether they would not let their son take his college course abroad. Several of our smartest young electrical engineers have attended Continental and American polytechnics and colleges, in some cases also going through foreign workshops. Of course, we have various scholarships and exhibitions, and many deserving young men have been assisted in this way.

If the college course cannot be taken, the youth should enter a large electrical works as improver. By hard work and some tact he should be able to move about, and may eventually get on to outside erecting work, or the test bed, or in the drawing office. The large new electrical works, which have been established in this country offer much greater opportunities for improvers than some of the older concerns. They will have none of the premium system; everybody starts fair, and from what the writer has heard, ability is quickly recognised and rewarded.

A good deal of what follows will naturally be applicable also to the young man who is not able to have a college training, and it is by no means to be taken for granted that the college-trained man will beat his less fortunate student. Many of our most prominent engineers had no college training. The student should remember that the greatest efficiency is attained by not attempting too much, but by *doing well* the work he has in hand. On no account should he let a difficulty pass without at least attempting to find the solution.

ITS PRIMARY AIM.

The primary aim of a college training is to teach the youth to reason scientifically, and think about and discuss engineering problems, so that he is not merely a man who carries out the ideas and inventions of others, but can himself originate. The work of an engineer proper, as distinguished from that of a mechanic, is headwork rather than handiwork, and his proper sphere lies in thinking and scheming, and in applying that knowledge which has been defined as "the art of *directing* the Great Sources of Power in Nature for the use and convenience of man."

The word *directing* here is the key to the situation. In the past, theory lagged behind practice, whereas we have now reached a point where theory leads the way, and must therefore be studied in advance. In these days of keen competition, engineers are obliged to use the *minimum amount* of material and labour,

and also give strict guarantees of the general fitness of their work. It is only by judiciously combining theoretical knowledge with practical experience that this can be done.

In many of the best colleges original research and experiment are carried on to a considerable extent, not merely by the teaching staff, but by the students themselves. There are always problems cropping up which require investigation, and for which engineers engaged in active professional work have neither time nor facilities. These are more and more being investigated in engineering colleges, and in Switzerland and Germany it has been a great factor in drawing together the works and the technical colleges or polytechnics as they are called.

CHOICE OF A COLLEGE.

In choosing the college a good deal depends on the personality of the professors and their assistants, for the boom in technical education has, like all exaggerated movements, had a tendency to overrun the mark. The sudden demand appears to have exceeded the supply of good technical teachers, whilst the low salaries offered do not help matters.

Engineering at Cambridge has recently ranked high, but both Professors Ewing and J. J. Thompson are now leaving, the first going to the Admiralty, and the second to the States. Cooper's Hill has a good name, whilst in London there are the Royal School of Science (Professor Perry), University College (Professor Fleming), Central Technical Institution (Professor Ayrton), Finsbury Technical College (Dr. S. P. Thompson), King's College (Professor Ernest Wilson), and so on. In the provinces there are the Yorkshire College, Owens College, Durham College of Science, and the Glasgow University, etc. The usual course is for the student to aim at getting his B.Sc., or, at any rate, the Associateship of his college, but there are other advantages. Thus, the student will attend the debating society, or engineering club, and learn to express himself tersely and to the point. Tone and the making of acquaintances are useful features of college life.

THE TECHNICAL INSTITUTIONS.

The young man will in due time become a student of the Institution of Electrical Engineers, and, possibly, also, the Institution of Civil Engineers, if he can obtain the necessary signatures, and pass the examination. The Institution of Mechanical Engineers and the Iron and Steel Institute, etc., are useful to join after being in business for some time. The limiting age for students in both the institutions of Civil and of Electrical Engineers is twenty-five years. Before that time arrives the young engineer should have specialised or had particular experience in some branch of engineering, and he will be well advised to collect together all the data he can on the subject, and write a paper for one of the above mentioned Institutions. Premiums are given for the best papers, and the Miller scholarships and prizes of the Civil Engineers are most valuable on account of the standing which they give to those fortunate to secure them.

For the very clever student there are various scholarships, such as those associated with the famous Engineer-Whitworth, also National Scholarships, which are often won by engineering students. These, however, call for exceptional abilities in the passing of *written* examinations. The student would be wise to not reckon too much on examinations, as they are, after all, only a poor guide compared with the test which life puts upon us. In the affairs of the world the brilliant student is often beaten by some classmate of only medium ability. "Memory men" are not usually the best material for engineers.

VACATION WORK.

During the college course there will be the usual long summer vacations. These should be spent in practical work of some kind, either on a temporary job in a mechanical or electrical engineering establishment, or in some civil or mining engineering work. This has been the practice in Scotland for some time, and it is somewhat similar to the so-called sandwich system, in which the usual college course of two or three years is extended to four or five years, six months or shorter periods being taken alternately at the college and in a works. In this way the student's interest in the theoretical side is stimulated. Continuous rounds of lectures from professors' notebooks are liable to get monotonous, and some educationalists and engineers appreciate this fact, and are trying to improve matters.

In the writer's opinion, if the student has already had shop experience in a small works, he can obtain most of the advantages of the system by employing his vacations in engineering work, or in travelling abroad and seeing foreign works.

Whilst on this subject, it is necessary to mention that the Testing and Training Institution of Charing Cross Road lays itself out specially to give an electrical training on what is practically the sandwich system. Various works and engineers in charge of electric light stations are affiliated to the institution, and by a payment of £100 a year for three years the student is moved about, and appears to obtain a fair training. Many students go as assistants in central stations pointer dodging on the switchboard gallery, or similar monotonous occupations. The system provides an easy way for parents to hand over their responsibilities to others for a fixed sum, but in the writer's opinion the electricians manufactured on this system are not brilliant.

LARGE ELECTRICAL SHOP.

In choosing the large shop, geographical situation goes for something; for the best engineering experience is undoubtedly to be obtained in the North of England and in Scotland. Life is more strenuous there than in the south, and the traditional engineering atmosphere has distinct value. It may easily happen that if a student has been successful at college his name may already have become known to the principal of an electrical firm, who may take him as assistant on the test bed. Of all departments in a works proper, the test bed is most valuable, for the student has opportunities of seeing everything going on, and if he is already a good mechanic, he can grasp all the details without actually working at them. He will also observe the method of organising and running a large business as compared with the small one he was in previously. With some experience of armature winding, he should soon be a valuable man to his employers to send out on outside jobs, and outside work is the thing to go for, as it throws one into contact with other engineers. Through it he may get a berth in some central station, or may possibly be taken on as assistant to a consulting engineer, or, as in several cases the writer knows, he may be sent out with a plant to the Colonies, in which case he will most likely be retained as resident engineer.

A good plan to pick up useful experience for central station work, whilst at the same time seeing something of the world, is to take a voyage or two as fourth engineer on a merchant steamer. If she is not a new boat, and there are some breakdowns *en voyage*, the

young engineer will be weaned from looking to the manufacturer in case of breakdown, which telegraphic facilities on shore are apt to lead to. He will probably also learn his own insignificance, a thing which must be learnt sooner or later.

Some men are cut out for office work, and in that case they should get into the drawing office as soon as possible, where, if they have ability, they will quickly pass to designing of dynamos, machinery, switchboards, transformers, and possibly engines, hauling gears, pumps, etc., also planning central station pipe systems, cable networks. There is great scope for good men in the drawing office, and the conditions of employment are much better than formerly. If he has a bent for invention—the writer means the genuine thing, not mere mechanical improvements—he would do well to accustom himself to making searches at the Patent Office Library, a most valuable institution, which is not so well known as it should be.

THE COMMERCIAL SIDE.

If the young man shows any ability for commercial work, the next step is into the estimating department, where he will learn the necessity for, as well as the absurdities of, specifications. He will learn how to take out prices from curves and prime cost sheets, analyse tenders, carry on technical correspondence, file data and catalogues, etc. Afterwards, he may be sent out to follow up inquiries, but this requires a particular temperament, good address, and much tact.

In this connection it is well to remark that if there is one thing in which the training of electrical engineers, as now carried on, breaks down, it is that very few ever get an opportunity to learn the commercial side of the business. Yet the engineer more than most men, is continually running up against questions of a financial bearing. As a result of this lack of commercial training, engineers are very often in the hands of non-technical people, such as accountants, secretaries, to say nothing of directors, figure-head and otherwise. This playing second fiddle to the purely commercial man is, after all, partly the engineer's own fault for becoming so absorbed in his technical work.

When being trained in the workshops the young man is cut off from all knowledge of accounts, correspondence, and commercial work generally, and when at college there is a silly sort of tradition that he ought to study engineering science for the love of it alone. It is considered *infra dig.* for questions of price to be brought into the discussion. To a certain extent this is right, but if he is wise he will begin to collect and study makers' catalogues even whilst at college.

Some engineers are fortunate to pick up commercial experience whilst they are learning the business, but for the majority this is not possible, and it is difficult to see how they are to be taught unless it is included in the college course. One thing is certain, that if the electrical engineer does not take steps to have more commercial sharpness, he will continue to play second fiddle to the purely commercial men. Several members of the Institution of Electrical Engineers have never had an engineering training; they depend on assistants and themselves watch the financial end. Personally, the writer considers there ought to be a rule preventing anyone becoming a full member of the Institution who had not had at least two years' workshop experience, not in clock making or glorified plumbing, but in heavy engineering work.

For anyone who has a special aptitude for the commercial side of the business, a little time in a general shipping or merchant's office is excellent experience. A knowledge of commercial law, accountancy, etc. is also useful, for, besides technical information, there are innumerable things which the electrical engineer may have to tackle at some point of his career. In fact, no engineer worth the name ever finishes his education. There are, for example, such questions as the organisation of factories, the management of men, amalgamation with other firms, extension of works or moving to another centre, opening of branches and agencies. He must be able to appreciate at a glance the merits of an improvement or invention, know the peculiarities of the Board of Trade and Local Government Board regulations and restrictions, have a working knowledge of patent law, parliamentary procedure in connection with Bills, etc. He is just as likely to have to outline the buildings of a power house as to design a dynamo or transformer, and there is every probability he will have to face various problems of main line railway working. In electro-chemistry and metallurgy the possibilities are infinite.

PAYMENT.

Regarding financial results, it is a fact that for the majority they are only poor, for at the moment there is overcrowding. After years of practical work and a long period spent in mastering the theoretical side, a young engineer can consider himself lucky if he gets £120 a year. The fascination of electricity has resulted in drawing a very numerous and intelligent class of men into electrical engineering, and one has to work with indomitable energy and zeal to get into a position of prominence. There are many prizes, however, for those who can win them. Some electrical consulting engineers earn large fees, whilst the profits of electrical inventors have been pretty considerable. It is well to remember, however, that the value of a training is not to be gauged by the maximum salary obtainable in a minimum time. The thorough knowledge derived from varied experience will, in the long run, command the best salary.

One advantage which engineering has over some of the professions is that it is open to all, and, given ability and hard work, it is possible for anyone to rise to the highest positions. There is the freest competition, and, although in the earlier stages money may be a help, yet in the end ability is given every chance to show itself.

Everything points to the probability that in the near future engineers will attain to a position of considerable power and influence in the social organism. Their work in the management of large bodies of men, in organisation and financing, together with their accurate habits of thought, active life, etc., specially fit them to be leaders and advisers of men—in fact, statesmen in the true sense of the word.

When we look back, we find that in the beginning, when the world was superstitious and ignorant, its rulers were priests; then came the soldiers, who have disciplined it; and now we have the lawyers, who have established civil rights. Inasmuch as the great questions of the immediate future are industrial and scientific, the balance of power should lie largely with the engineers.

It rests with the engineers themselves as to how long this will take. Public opinion needs educating, and one step in this direction is for the engineers of to-day to take a greater part in public affairs. The public must be brought to recognise the revolution in industrial and social affairs which is resulting from the activities of the engineer.

THE MANUFACTURE AND USE OF CONCRETE.

BY

A. LEGG, M.Inst.C.E.

The previous article was largely devoted to tests of Portland cement for fineness of grinding, specific gravity, strength, hydraulicity, speed of setting and soundness. The author now confines himself to the essentials of good aggregates and their preparation, the computation of voids, methods of mixing, etc. He gives some practical hints on the working of concrete.—Ed.

II.

I SHALL now proceed to discuss the materials or aggregates which are to be used in conjunction with the cement to form the concrete. The essentials of good aggregates are:—

1. Hardness and density.
2. A moderate degree of porosity, *i.e.*, as opposed to a vitrified surface.
3. Angularity of fracture.
4. Variation in sizes of particles.

Broadly, one may group the aggregates under two heads.

1. Materials found in nature ready for use.
2. Materials prepared for the purpose.

GRAVEL.

Under the former head the only material which is used to any extent is "gravel," consisting of more or less rounded pebbles of varying sizes. From whatever source these are obtained the usual preparation necessary is screening and washing. This material does not fulfil all the conditions laid down. It usually possesses a smoother surface than is desirable to afford a good hold for the cement, and the shape is not angular, otherwise it is often very hard and durable, being, as it were, the survival of the fittest portions from the trying ordeal to which it has been subjected during a lengthened period in the rubbing or knocking together of the fragments in the river bed or sea-shore, whereby the softer portions have been reduced to sand or mud, and only the harder remains.

PREPARED MATERIAL.

Into the second class will fall, as by far the most important, all materials which are prepared by breaking or crushing the natural rocks, and these are the materials on which the engineer chiefly relies. This source is practically unlimited. Any rock which will furnish a building stone of good quality will, as a rule, also furnish good aggregates for concrete, and many rocks which do not furnish building material of good quality, owing to their hardness and difficulty of dressing, or to the difficulty of obtaining from them sufficiently large blocks, may produce very excellent material for concrete.

This class of material is generally superior to natural gravel. When broken it usually possesses great angularity and roughness of surface, and it is from this class almost exclusively that can be obtained material fulfilling *all* the requirements already given as desirable.

Much might be written concerning the different methods of reducing the rock to the sizes of fragments required. Suffice it to say, that stone reduced by a modern percussive action stone-breaker is preferable to that broken by hand, or by rolls, as it generally gives a greater variety in size of fragments.

One other small variety of material still remains to be mentioned, viz., that obtained by the breaking of artificial substances, such as bricks, or clay burned in the rough specially for the purpose. This last is often useful when suitable rock or gravel is not to be had, and if thoroughly burned forms an aggregate which will make good sound concrete.

As to the best size to which to reduce the material, a usual stipulation is that it should all pass through a ring 2 in. in diameter, and for ordinary foundation work this gives excellent results, but when watertight work is required, 1½ in. gives better results. Of course, generally the cost is greater the finer the material, but, within limits, the extra cost of crushing the smaller size is compensated by the greater ease of mixing and subsequent working.

Having considered the various ingredients required in the composition of the concrete, we will now discuss the proportions of each of these which should be used, and the methods by which they are to be brought together so as to produce the best results.

It might appear that the engineer has here absolutely free scope, trammelled only by considerations of economy, but there are limits, and rather narrow limits, within which he must confine himself, if he is to obtain satisfactory results.

Here, again, as in other details, he is governed by the purpose of the proposed work.

DETERMINING THE VOIDS.

The following remarks as to the method of determining best proportions will apply to the production of watertight concrete, for which purpose the highest possible quality of work is required. For other purposes the engineer will allow himself such departure from the results obtained by these methods as his experience may warrant.

Having selected the particular material to be used for aggregates, the first step will be to determine the proportion of voids or interstices existing when a mass of the aggregates is thrown together. The proportion of *mortar* in the concrete must then be made sufficient not only to completely fill all these voids, but also to allow a sufficient excess to completely surround each particle of the aggregates, so that no two adjacent pieces shall touch.

The simplest method of determining the voids is to fill a vessel of known capacity with the aggregates and then measure the quantity of water required to fill the interstices, taking care, of course, to eliminate as far as possible any error from absorption.

The volume of voids being thus obtained, we must add a percentage to allow for the surrounding of each particle. From 10 to 15 per cent. is usually sufficient. If the quantity of *sand* used is alone made *equal* to the voids, the addition of the cement will generally produce sufficient *mortar* to cover this percentage, as will be pointed out later.

The actual percentage of voids will vary with different classes of material and with the size of the particles. Generally speaking, finer material having a smaller percentage than coarser, and more marked still is the effect of a great range of variation in the sizes of the particles, the smaller ones then filling the voids between the larger and reducing the total percentage. For material 1½ in. to 2 in. maximum and of varying size below that, the proportion of voids to total volume of aggregates will generally range from 35 per cent. to 50 per cent.

By a similar process we may determine the proportion of cement required to fill the interstices of the *sand*. It will be found that the voids in an average sample of sand will lie generally between the limits of 30 and 40 per cent., and that a sample showing more than 40 per cent. would probably be so coarse as to be looked upon with suspicion for use in watertight work, unless with the use of an excessive quantity of cement. One part of cement to two of sand will, therefore, generally be found to give safe results, but the engineer desirous of using a larger proportion of sand than this should satisfy himself that the sand is of suitable quality. It may be useful to point out here that the volume of cement paste resulting from the gauging of one volume of Portland cement with water is only about 80 per cent. of the volume of the cement dry. So that sand having 40 per cent. of voids would require 50 per cent. of dry cement to completely fill the voids.

SPECIFICATIONS FOR CEMENT.

Being now in possession of the knowledge of the proper proportions for the ingredients, what is the best method of specifying them so as to obtain exactly the resulting concrete which we desire?

Occasionally one finds the proportions specified simply by stating that the proportions shall be one part of cement to so many parts of aggregates, *e.g.*, 1 to 5 or 1 to 6, as the case may be. In letting a contract on such a specification the engineer is laying up for himself the possibility of many friendly discussions with his contractor.

It is not an uncommon practice to specify the exact proportions of each ingredient as one part of cement to so many parts of sand and so many of aggregates. Now, if the engineer in writing his specification has in view the use of definite materials, of which he has already obtained by some such method as that described the correct proportions, this is allowable, otherwise it is unsatisfactory, as he is giving himself the somewhat difficult task of finding materials to suit his conditions, and he may eventually find that by adhering to the proportions specified he is not using the materials available to the best advantage, *e.g.*, he may be using more sand than the aggregates actually require, and so obtaining a weaker concrete than he would otherwise get with the same proportion of cement.

The method which the author has found the most generally satisfactory is to specify that one part of cement shall be used to so many parts of aggregates and sand together, and that the proportion of sand to aggregates shall be such as the engineer may determine.

MIXING.

We now go on to consider the method of mixing the ingredients. As the quality of the resulting concrete will greatly depend upon the thoroughness with which this operation is conducted, it is one requiring careful consideration. The condition of perfection to be arrived at is that each grain of sand in the mortar shall be surrounded by a layer of cement paste, and that each particle of aggregate shall be surrounded by this mortar, which shall also completely fill all voids.

These results are, no doubt, most completely obtained when the sand and cement are first intimately mixed together in the proper proportions, afterwards adding the proper proportions of aggregates and thoroughly mixing the whole mass, and, if the sand and aggregates are delivered on the work separately, this is undoubtedly the best method of working. If, however, the aggregates and sand are delivered together as a product of the crusher or otherwise, it is not worth while to separate them in order to adopt this method.

IMPORTANCE OF THE DRY MIXING.

As to the actual process of mixing, there are now many machines in the market for the purpose, which give first-class results when properly worked, and when large quantities have to be dealt with machine mixing possesses many advantages over hand labour, more especially in a country where labour is dear. At the same time, very excellent results can be obtained by hand labour, which, for works of moderate dimensions, will compare favourably with mechanical mixing, both as regards quality and cost.

Whichever method is adopted, the most important part of the whole process is the dry mixing, one turning of the materials dry doing more to bring about intimate mixing than several after water is added.

Three mixings of the materials dry and two wet will generally suffice to produce good results. The water should be clean, should always be added very gently through a rose, and never poured on in a jet, or, worse still, out of a bucket, as is often done, as it simply washes the cement out of the mixture.

PROPORTION OF WATER.

The best proportion of water to be used is a question which has, perhaps, given rise to more discussion amongst engineers than any other point in connection with the subject, and with it is associated the question of best laying and working the concrete in. We have on the one hand the *dry* method of mixing, in which only sufficient water is to be used to enable a film of moisture to be brought to the surface by hard and continued ramming, and, on the other hand, the *wet* method, in which concrete is to be so sloppy and wet that it almost falls together without any ramming. Each of these methods has its advocates, who are, as is usual in such cases, inclined to ride their hobby to death; whereas, if used intelligently, each method undoubtedly has its special uses and advantages.

There can be no doubt that concrete made with a minimum quantity of water is stronger than one in which an excess of water has been used. This is established by experiment. Therefore, when strength is the most important factor to be considered, the concrete is best mixed fairly dry and well punned. There are many cases, however, where strength is not the most important factor, but is secondary to watertightness.

MAKING WATERTIGHT CONCRETE.

Now, whether or not watertightness can be obtained with dry mixed concrete, is the very point on which the controversy turns. As a result of considerable experience with both methods, I am prepared to admit that it is possible to obtain excellent results in this respect with the dry mixing; at the same time, I am convinced that the personal element enters far too much for it to be relied upon always to do so, and therefore, for safety sake, where watertightness is essential, I always prefer the concrete to be put in soft. Let me explain clearly what I mean by "soft."

1. The concrete should be so soft that one cannot stand upon it, when in a heap upon the mixing stage, without sinking over the boots.

2. There should be no *free* water, and never any suspicion of water *flowing* from the surface when it is being worked in position.

The actual quantity of water required to bring about this condition will, of course, depend greatly upon the porosity of the aggregates.

In this soft condition punning or ramming is useless. What is required is that the concrete shall be well worked or chopped into solidity with a thin narrow tool—an ordinary grafting tool is a very efficient

instrument—in such a way as to allow any enclosed air to escape and the mass to fall together by gravitation.

Concrete put in in this way need never cause the engineer a moment's anxiety as to whether or not it will hold water, whilst with concrete put in in the dry way, unless he personally sees every inch of it put in, he will never be quite free from a haunting fear that the water will by and by demonstrate that for a few moments, at one time or another, the very rigid supervision necessary had been relaxed.

Another danger to be guarded against with the dry mixing is, that the hard ramming necessary is liable to fracture the particles of the aggregates, and to leave the fractured surfaces without any mortar between them. And again, ramming has little or no effect in bringing to the surface included air, except from very near the surface, its effect is rather to completely seal it up in the interstices and render escape impossible.

Concrete should always be laid in moderately thin layers, not exceeding, say, 9 in., but it is better to lay about two or three such layers on each other immediately, so as to attain a thickness of, say, about 2 ft., rather than to allow each thin layer to set before adding the next.

SOME DEFECTS.

A careful examination of a large surface of concrete which has water under pressure behind it, and through which percolation is taking place, will generally reveal two causes of weakness. First, there will be found *patches* of larger or smaller extent and of irregular shape over which the water oozes. This is evidently a defect of mixing. The concrete in the patches has either been deficient in mortar, or else the aggregates have not been well mixed in, so that voids exist.

Secondly, water may be found oozing along a *line* which marks the junction of new work with old. This is a very prevalent defect. Too much care cannot be bestowed upon the bonding of new and old work. By old work is meant work which has already set. It may be but a few days old.

HINTS ON THE USE OF CONCRETE.

To insure a good joint the old surface must be absolutely clean, and a layer of mortar should be laid upon it for the double purpose of embedding any rough stones which will inevitably fall to the tail end of the new concrete being placed, and of filling up irregularities in the old surface and cementing the two portions together.

In laying concrete on wet foundations great care is necessary to prevent the washing out of the cement by the water present. I do not propose to deal with the laying of concrete under deep water, as this subject belongs more properly to a discussion on harbour works. I shall refer only and briefly to cases where concrete has to be laid in a position where it is found difficult or impossible to have the foundation dry, as frequently happens in deep pits for bridge foundations.

One frequently sees concrete mixed almost dry being thrown into a wet foundation, in order, as it is said, to take up the water lying there, and so keep it dry. This is very bad. The concrete should always have its full allowance of water in mixing, whether the foundation is wet or dry.

When the foundation cannot be made quite dry then the concrete should be placed in *from one side* in a sufficiently deep layer for the surface to be always above the water, and worked gradually across the pit, driving the water before it.

If pumping has to be resorted to, it requires to be done with great care, so as to avoid washing out the cement. It is a safe plan never to allow the surface of the water to be pumped below the surface of the layer of concrete being put in. Concrete may, with these precautions, be made quite as sound and watertight on a wet foundation as on a dry.

The laggings used for face work should always be greased so as to come away without plucking the face, as the natural sink so obtained looks better and wears better than a face got up by floating or rubbing after removal of the laggings.

EFFECTS OF CONTRACTION AND EXPANSION.

When designing work to be constructed in concrete, it is well to keep in mind the effect of contraction and expansion, and, if possible, to devise some means of avoiding ill-results. Work carried out in masonry and brickwork does not call for any such precautions, because the effect being distributed amongst a large number of joints is so slight at any one point as to be negligible, but when we have a mass of concrete of great extent in any one dimension without any joints, it is necessary to adopt some precautionary measures.

Just what the exact coefficient of expansion for concrete is has not yet, so far as I am aware, been determined accurately, but it is evident that changes of temperature must produce great stresses in its substance, expansion giving rise to probably a certain amount of displacement or distortion (the amount of which will depend to some extent upon the particular form of the mass), and it is quite possible also that under certain conditions some effect might be produced analogous to that of cleavage in some of the older rocks, with the result that at such cleavage planes the strength of the material might be adversely affected. This, however, could only be expected to take place on the mass becoming confined, so that distortion or displacement could not take place even when the stress was approaching the ultimate crushing strength of the concrete, a condition which will not very frequently occur. Displacement will probably be the means by which compressive force, due to expansion, will most frequently make itself manifest.

Contraction, on the other hand, will subject the structure to tensile stresses, assailing the material on its weakest side, and after certain limiting dimensions have been exceeded will assuredly, under ordinary conditions, produce fracture in the structure.

I consider that a concrete wall of a length of 100 ft. and over, which will be exposed to the full effect of atmospheric changes of temperature, ought to have expansion joints provided. In a wall which has to hold back water, such as a reservoir wall, the joint must be so designed that, when it is most open, during the period of lowest temperature, the passage of water will be prevented. This may be accomplished by the adoption of some such device as a tongue of plastic bitumen within the thickness of the wall.

When this condition has not to be fulfilled, then such precaution is not necessary; indeed, the expansion joint then becomes unnecessary, except in so far as it selects the line on which the movement shall show, instead of leaving it to chance, which usually results in unsightly cracks.

A more satisfactory method of providing for expansion and contraction is by avoiding as much as possible long straight lines in the design, and adopting instead curved lines. The facing of the concrete with masonry or brickwork will also have a beneficial effect in reducing the range of temperature changes to which the internal mass of concrete will be subjected. The effects of often repeated expansion and contraction in a concrete structure is a very important question, requiring very careful investigation.

IS ANYTHING THE MATTER WITH PIECE WORK?

BY

FRANK RICHARDS.

The author criticises premium systems in the light of practical experience, urging among other things that they offer a reduced incentive at the precise time when the need of incentive is most urgent.—ED.

ATTENTION is invited to the accompanying diagram, which is easily understood. The purpose of it is to show the actual earnings of the workman, and of course also the labour-cost to the employer, for any given amount of work done under either day work or piece work at different rates, the Rowan premium system and Mr. Halsey's premium plan. The amount of work done is represented by the lengths of the horizontal lines and the wages paid are represented by the vertical lines.

THE ROWAN SYSTEM.

The Rowan system starts with a fair day's work, although that may not be the term used to designate it. The unit assumed is the amount or quantity of work which the man should ordinarily be expected to do in a day for the ordinary day's wage without any special inducement. The premium is earned only by the work which is done in excess of the regular day's work, and the premium earned is according to the time saved in doing the work. If double the work is done in the given time then one-half the time is saved and the man is paid one-half in addition to his regular wages. If the man does one and a-half times his day's work then one-third of the time is saved and he is paid one-third more than his day's wages, and so on. The basis of computation is thus fixed and cannot be juggled with, but the inducement constantly decreases with the amount of work done, so that whatever a man may do he can never by any possibility double his earnings. Mr. Halsey's premium plan will be designated hereafter as *the* premium plan.

Referring to the diagram it will be seen that both day work and piece work, whatever the rate of the latter, are represented throughout by straight lines. A discouragement curve represents the Rowan premium system and Mr. Halsey's premium plan has a bend sinister. It was impossible to include Mr. Gantt's bonus system in the diagram because a part of it, the part where you do not quite earn the bonus, must be represented by an *invisible* line.

It cannot fail to strike the observer at once that in the premium plan the work which is done in the earning of the premium is straight, absolute piece work. The name cannot disguise it. The line in the diagram for the premium plan at one-half rate is exactly parallel to the half rate piece work line, the wages earned rise equally in each with equal increments of work done. So the three-eighth premium rate is parallel to the three-eighth piece work rate, and so on. If in making the premium plan bargain, the proposition were made to the man to first do his allotted quota and be credited with his day's wages and that then he should go to work by the piece for the remainder of the day at one-half the day rate, that would be the premium plan in every particular.

THE PREMIUM PLAN CRITICISED.

The partial piece-work character of the premium plan being undeniable, a paper whose topic is piece work must claim the right to handle it freely and without apology. The premium plan was invented by its originator nineteen years ago; it was put in operation in the shop at Sherbrooke, Canada, thirteen years ago, and was first brought to the notice of this Society in a paper twelve years ago. The plan, I know, has been proposed and advocated in all honesty of purpose; it has been pushed with earnestness and

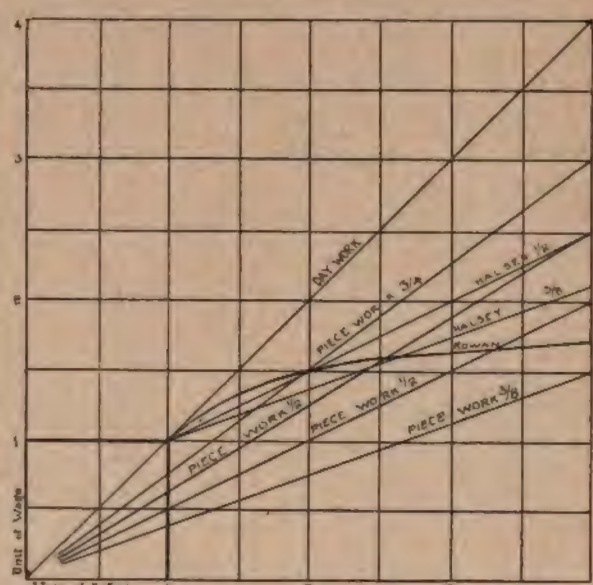


DIAGRAM SHOWING EARNINGS UNDER THE DIFFERENT SYSTEMS.

persistency. As a result the premium plan is in operation in a few machine shops and nowhere else. I venture the personal opinion, based on the fullest available information, that perhaps two per cent. of the machine work in the United States is done under the premium plan, while ten times as much is done by undisguised piece work and much more than half is still done by the day.

It is not at all apparent that there are any peculiar conditions in the machine shop which demand any different plans of wage adjustment than are prevalent in the other trades. While a knowledge of the premium plan is now widespread, the plan has not made itself appear so good a thing that any of the other trades have taken it up. It would not work with the shoemakers of Lynn, the hatters of Danbury, the glovemakers of Gloversville, or the stitchers and starchers in the collar shops of Troy, for they all work by the piece, as do most of the manufacturing trades, and the ultimate possibilities of economical production are thereby secured as completely as they can ever be claimed to be under the premium plan.

HOW IT WOULD WORK WITH BRICKLAYERS.

We might by an effort imagine the effect of proposing the premium plan to one of the trades outside the machine shop. Let it be tried on a lot of bricklayers. Say that it is first agreed that the day's wages are earned when five hundred bricks are laid, and that the premium plan begins right there. The bald proposition is, first, that if five hundred bricks are laid five hundred bricks will be paid for. This is so far meant to be an honest bargain on both sides. If you don't lay another brick above the five hundred we will have no cause of complaint. Well, now, having agreed to pay for the laying of the five hundred bricks, when the five hundred bricks are laid go on and lay as many more as you can. If you lay seven hundred and fifty bricks we will pay you for laying six hundred and twenty-five bricks; if you lay one thousand bricks we will pay you for laying seven hundred and fifty bricks, and so on. It will be very plain that under this arrangement the workmen are clearly the gainers, for if you lay more bricks you get some more money, and every additional cent you get is, of course, clear gain to you. The absurdity of this thing, when dealing with bricklayers, is sufficiently evident; are machinists so vastly different from bricklayers?

They must be different or else there are some things about the premium plan upon which I need information. One of the inherent and inseparable conditions of the scheme would seem to be the voluntary acceptance of it by the individual workman. It depends entirely upon himself how much the man shall do after the allotted amount for the day's work is done. He may do much or he may do little, and therefore if he so chooses he may do none at all, but just be content to work along at his usual rate and just earn his day's wages. The premium plan, as I understand it, is ostensibly, entirely a coaxing and not at all a driving plan; and yet it is a matter of common knowledge that in the State of New York alone there have been two determined strikes against the premium plan in the past year. This seems odd. If you don't choose to do what you are formally and distinctly allowed to choose whether you will do or not, what possibility for a strike can there be in that? Can it be that premium plan enthusiasts sometimes venture to put on to the plan some features which do not belong to it? I cannot imagine any other way in which a strike could be possible.

THE CUTTING OF RATES.

If they can tag things on and objectionably modify the premium plan they can also knock things off. The one essential safeguard of the premium plan continually insisted upon is that there shall be no cutting of rates when once established. This must inevitably involve injustice, because prices both of labour and of finished products change continually, and there must be, if justice is to prevail, sometimes a cutting of rates and sometimes an advance of rates. So far as it is possible to fix honest prices, and to maintain them there as long as it is just to both sides to do so, it can be done as well with straight piece work as with any premium plan, and is so done. For instance, I have knowledge of an establishment in the machine line, whose identity I must not disclose, where fifteen hundred men are employed and where piece work prevails in all departments, so that ninety per cent. of the productive work of the entire establishment is done by piece work, and it may be said of that establishment that there is no cutting of rates there, just as truly as I suppose it is ever said of works where the premium plan is in use. All prices when made run for a year. They are not arbitrarily imposed by the employer or his representatives, but are the outcome of fair and free and friendly conference, and when changes of price are imperative they are adjusted again in the same way. The works are prosperous continually, and the relation of employers and employés are less strained than they were under other arrangements.

It must be evident that none of these premiums or bonus, or other curved or bent, or defective line schemes, whatever they may claim in the way of quickening the pace of the worker and increasing the output, can be the most effective, for the reason that they offer a reduced incentive at the precise time when the need of incentive is most urgent. It is the last piece done which comes the hardest, and it is absurd to offer the man half-price or less for doing it. With either of the premium plans doing its best in the way of increased output and reduced labour cost per unit, and with piece-work prices adjusted to precisely the same price per piece, the inducement to the worker to increase his output still further must be greater under the piece work than under the premium plan. The guarantee that prices shall not be cut is precisely as applicable to piece work as to the premium plan. The latter has absolutely no monopoly of honesty, no assurance of price maintenance any more than the other. With equal temptation to cut, and with the same human nature in the boss, the chances of cutting will average precisely equal.

THE ADVANCE OF PIECEWORK.

With no one having the slightest interest in pushing or advertising piece work, it is advancing on its merits as the most honest way of paying for repetitive work in the machine trade as in all others. It is worth while to note its popularity and progress especially in the extensive line of railroad work. The testimony at the meetings of the various railroad organisations is very pronounced in this direction. At the meeting this summer of the Railroad Master Blacksmiths one man stated that absolutely every job in his shop was done by the piece. When the price could not be placed on the work to be done it was placed on the "heat." Perhaps it may not always be possible to do this in the machine shop, but whenever the opportunity arises to consider the mode of payment it should always be in order to ask: What's the Matter with Piece Work?

A paper read at the New York Meeting of the American Society of Mechanical Engineers.

TALKS WITH INVENTORS.

I.—DR. BARTON, PRESIDENT OF THE AERONAUTICAL SOCIETY.

WHILE many engineers are deep in questions of electrification, permanent way and communication by tubes beneath the earth, it should not be forgotten that there are those who are no less deeply concerned in solving the problem of aerial flight—a problem which, if satisfactorily determined, would tend to place ordinary systems of transport somewhat at a discount.

The writer recently chatted with one of the most enthusiastic of these gentlemen who are endeavouring to make a conquest of the air. The scene was an immense wooden shed at Alexandra Park, open at one end to the sky. The aeronaut was Dr. Barton, President of the Aeronautical Society, whose airship, rapidly approaching completion, loomed large in the centre of the shed.

The ship is described by the inventor in another part of the Magazine. It is the largest airship yet attempted. The bamboo framework of the ship proper suggests its nautical prototype. It is nearly twenty feet in depth, and another forty feet has to be allowed for the cigar-shaped balloon. All the parts are either lashed together or clamped in castings of aluminium; it is innocent of nails or screws. A central deck or gangway runs from one end to the other, and connects up a number of platforms, which carry the machinery and crew. Three sets of movable aeroplanes—10 in each set—are placed in the bows, amidships and at the stern respectively.

We gathered in conversation with Dr. Barton, that he was born at Dover in 1861, and was educated at Harrow and Cambridge. He has always been fond of athletics, and some years ago rowed in the 'Varsity trials for Cambridge. He received his medical training at Cambridge, and in St. George's Hospital, London, and is now President of the Medical Society at Beckenham, where he has been in practice for the last fifteen years.

It was over twenty years ago that Dr. Barton first took an interest in airships, and his first attempt at constructing one resulted in a model almost identical with the machine in which M. Santos Dumont encircled the Eiffel Tower. After constructing several self-propelling models on the purely navigable balloon system, Dr. Barton turned his attention to aeroplane machines, but finding both these unsatisfactory, he finally combined both principles, and after several experiments with models, was so successful that he secured an order from the War Office to construct an airship suitable for service in warfare. This is the ship now under construction at the Alexandra Palace.

Having taken careful stock of the ship, its aeroplanes, motors, ingenious ballasting arrangements, etc., we sounded Dr. Barton as to the time taken in the evolution of his idea.

"I was engaged for two years on the plans," he said. "Almost endless experiments were tried before even the materials of construction were finally adopted, and then, of course, every separate detail had to be carefully thought out."

"You have relied mostly upon bamboo?"

"Yes," said the Doctor, turning to a stack of bamboo masts about six inches in diameter, and many feet in height. "Can you lift this?"

The interviewer braced his muscles for a feat of strength, but in the result was able to lift it easily with one hand.

Taking a piece of thin bamboo, about 8 ft. long, the Doctor illustrated its strength and rigidity by showing that the bar would easily support the weight of a man.

"It has a great deal of silica in its

composition," he remarked, "and made short work of our sawing tools. Aluminium is the *metal* chiefly employed," he added, "and, as you see, steel has only been used for the shafts of the propellers and aeroplane frames."

"The machine is now practically complete, is it not?"

"Well, nearly. Under favourable circumstances I could make an ascent in a month."

Further questions elicited the fact that the delay is being caused not by any unlooked-for difficulties in construction, or even climatic reasons. Airship construction, just as ordinary shipbuilding, is subject to the ordinary difficulties and delays of commerce. Dr. Barton mentioned that the financial side of the business is occupying his attention, and he is making arrangements for the introduction of fresh capital.

"And you think that the *flying* machine has ultimately got to come?" we ventured.

"Unquestionably!" said the Doctor, with emphasis. "It is only a matter of time. You know how it is with a boy who is learning to swim. You hold him up with a cord to start with. Then, as he becomes more expert, you gradually loosen the cord until he can support himself by his own efforts. It is just so with the airship. I shall carry a balloon with sufficient hydrogen to keep her balanced just above ground; the aeroplanes will do the rest. Then, as our knowledge increases, this aid will be gradually withdrawn, until the ideal airship—that is, one composed entirely of aeroplanes and propellers, is arrived at."

"And the passengers?"

"The *crew*," corrected Dr. Barton, "will consist of seven persons. My own attention on the first trip will be devoted to taking observations. There will be also three engineers, an aeronaut, a helmsman, and my boy, who, by the way, is a capital little engineer, and thoroughly understands the motors."

Here we were shown the telegraphic system by which, on the Bowden brake principle, all the engineers will be in communication with the helmsman's platform.

"Of course, in an airship of this description there will be no promenading of the deck, and we see that your helmsman is stationed almost in the middle of the ship."

"That is so; the helmsman will be stationed there in order that he may be as near as possible to the aeronaut."

Dr. Barton then explained the means by which the water ballast will be worked, remarking that this system of ballasting will now be used for the first time. He also showed us his arrangements for giving the ship an ascending or descending motion by means of aeroplanes.

"You have already made several ascents, we think, in the ordinary way?"

"I have not had many trips, but rather exciting ones. On Coronation day I crossed the Channel with Mons. Gaudron in a balloon."

"And had rather a rough time, we believe?"

"Well, we were caught in a gale off Calais. The balloon went bump into the sea on the flats outside Dunkirk. Relieved temporarily of the weight of the car, it rose abruptly, and carried us a little further, when we were treated to another bath, and so on—finally we were carried across the surf to land, but it was a narrow escape."

LOCOMOTIVE ENGINEERING NOTES.

French Locomotive Practice.

For several years past—nearly a decade in fact—the predominant feature of French locomotive practice has been the adoption and rapid development of the de Glehn compounds for express passenger duty. With the able and hearty co-operation of M. du Bousquet on the one hand and of M. Baudry on the other, this system was embodied in the express locomotive types constructed for the Chemin de Fer du Nord and the Chemin de Fer de P.L.M., quite early in the nineties. The de Glehn engines built for those two great lines differed mainly in respect of the diameters of the four driving wheels, those on the Nord line being 7 ft. and those on the P.L.M. 6 ft. 7 in. in diameter, while the cylinders were of such proportionate dimensions as to give approximately identical tractive force. Up to the end of 1899 the Chemin de Fer du Nord had 60 eight-wheeled express engines on this system, Nos. 2.121–2.180, virtually alike in main design, but built in five successive batches, each slightly in advance of its predecessor in respect of power—mainly in the department of boiler-capacity, the steam pressure also increasing from 199 to 213 lbs. per square inch. The P.L.M. acquired 40 of its own variety of these locomotives, Nos. C.21–C.60, subsequently adding 90 more considerably larger and more powerful, Nos. C.61–C.150. The Midi, Etat, Est, and Ouest lines all adopted the de Glehn type, which had been brought out by M. du Bousquet on the Chemin de Fer du Nord, differing only in minor detail, their initial numbers being respectively 1751, 2701, 2401, and 503. All these engines had four driving-wheels coupled, 6 ft. 7 in. to 7 ft. in diameter two high-pressure cylinders, placed outside, about 13 in. to 13½ in. diameter, and two low-pressure cylinders, placed inside, 20 in. to 21 in. in diameter, each cylinder having a 25½ in. piston stroke; the total heating surface was 1,500 to 2,000 square feet, and the steam pressure 199 to 213 lbs. per square inch.

A New Development.

Then the Chemin de Fer du Midi took a fresh departure. For certain of its services it needed an engine with greater haulage power—that is to say, tractive force multiplied by adhesion weight—than the four-coupled de Glehns possessed. Accordingly, M. Moffre designed a ten-wheeled locomotive, a compound on the de Glehn system, but with six coupled wheels of smaller diameter than those of the four-coupled type, viz., 5 ft. 8 in., and with slightly larger cylinders, the four-wheeled leading bogie being retained. These engines, No. 1301, etc., proved so valuable that after a preliminary trial of No. 1301 on the Chemin de Fer du Nord—when she achieved haulage feats previously undreamed of—M. du Bousquet adopted the type and gave a first order of no fewer than fifty for his railway. They were built by three different outside firms and number, 3.121–3.170, many more being subsequently built. Originally intended for fast goods or heavy excursion passenger trains, they were soon found to be most efficient express engines also, less fast on the level and on falling grades than the eight-wheelers, but able to haul very heavy loads up considerable grades with surprising ease and swiftness. They were adopted also by the other French main lines, and a subclass came out on the P.L.M. and Midi lines, which obtained increased tractive force by further reduction of the driving-wheel diameter. These two main types with their minor class-differentiations thus became the almost exclusive features of modern French practice as regarded fast services, whether for passengers or for goods. The provisions for passenger stopping trains, suburban services, slow goods and mineral traffic differed of course *toto coelo* and require to be dealt with quite separately. But the service of *grande vitesse* in both its branches calls manifestly for first attention.

Latest French De Glehn Atlantic.

But quite recently the du Bousquet-de Glehn "Atlantic" engine of the Chemin de Fer du Nord has itself undergone a fresh and remarkable development in respect of dimensions. On the instruction of M. Solacroup, the able Ingenieur en Chef du Matériel et de la Traction of the Chemin de Fer de Paris-Orléans, M. de Glehn constructed for that railway, at the Atéliers of the Société Alsacienne de Constructions Mécaniques, an engine, No. 3004, of truly colossal proportions not only dwarfing the Nord and Great Western engines of the same type, but exceeding in weight even the locomotive giants placed on the Caledonian Railway by Mr. J. F. M'Intosh, Nos. 49 and 50, and on the North-Eastern by Mr. Wilson Worsdell, No. 532. This new French mammoth closely follows the lines of the Great Western "Atlantic," "La France." But the Orléans, No. 3004, is larger everywhere excepting only as to its driving wheels, which are identical in size, being 6 ft. 8 in. in diameter. The other principal dimensions of No. 3004 are as follow :—

Boiler—	
Diameter	4 ft. 11½ in.
Steam pressure	228 lbs. per sq. ft.
Tubes (Serve)—	
Number	139
Length	17 ft. 4 in.
Diameter	3 in.
Heating surface—	
Tubes	2,420 sq. ft.
Firebox	180
Total	2,600 sq. ft.
Firegrate area	33 sq. ft.
Diameter of h.p. cylinders ..	14¼ in.
Diameter of l.p. cylinders ..	23⅝ in.
Piston stroke	25½ in.
Diameter of coupled wheels ..	6 ft. 8 in.
Diameter of trailing wheels ..	5 ft.
Diameter of bogie wheels ..	3 ft. 2 in.
Weight of engine loaded ..	73 tons.
Weight on coupled wheels ..	36 tons.
Weight on trailing wheels ..	16 tons.
Weight on leading bogie ..	21 tons.

These fine engines will run the heavy fast expresses between Paris and Bordeaux which, when they clear the suburban obstacles that cluster near the French capital, are booked at an average inclusive rate of over 52 miles an hour, while the various stages between stops are booked at average start-to-stop speeds of 52 to 55½ miles an hour over a road which has long banks at 1 in 200 to 1 in 125, and with loads ranging from 200 to 300 tons behind the tender. These remarks do not apply to the still faster-timed "Sud Expresses" which are relatively light trains and are worked by the older and smaller engines, but which, being composed of International Sleeping Car Company's stock, are limited to a maximum speed of 100 kilometres or 62·1 miles an hour, whereas the trains consisting of the company's own ordinary stock are allowed to attain 120 kilometres or 74·6 miles an hour.

A Gigantic French 4-6-0.

But the newest express locomotive of the French Eastern Railway is in some respects still more unusual

in style. It has been designed by M. Salomon, the able Ingénieur en Chef du Matériel et de la Traction of the Chemin de Fer de l'Est, and built at the Ateliers of the Company at Epernay. It is a compound of the de Glehn type and is a larger development of the earlier 4-6-0 class—known as "Series 10"—in which the six-coupled wheels were 5 ft. 8 in. in diameter; the high pressure cylinders 13¾ in. by 25¼ in., and the low-pressure cylinders 21 in. by 25¼ in. The special peculiarity of the new engine consists in the great size of its six-coupled wheels, these being no less than 6 ft. 10½ in. in diameter. These appear to be the largest six-coupled wheels ever employed in any locomotive outside the "freak" order. Many years ago six 8 ft. 3 in. wheels were given to an experimental locomotive—on the "Estrade" system, all the carrying-wheels of the engine, tender and train being of the same extraordinary size. That experiment was purely of the "freak" character—like the Thuille locomotive shown in the Paris Exhibition of 1900 which also had 8 ft. 3 in. coupled wheels—*four*-coupled however—but which was never accepted as "practical politics." The new Salomon-de Glehn engine of the Chemin de Fer de l'Est is, however, a strictly practical locomotive and should prove exceedingly useful, although the need of wheels of such large diameter may fairly be deemed open to question in view of what is daily accomplished with 6 ft. 6 in. wheels.

The New Giant and its Duty.

Two engines of this class have been constructed. Their duty will be to work the heavy expresses which carry the chief traffic between Paris (including the English share) on the one hand, and Switzerland and Italy on the other. The Anglo-French portion is worked on two stages between Paris and the frontier at Petit-Croix, the engines being changed midway, at Chaumont. The Paris-Calais stage is fairly easy, the ruling grades being not more than 1 in 200. But in the eastern length the Vosges Mountains have to be crossed by grades chiefly at 1 in 125 and this necessitates ample locomotive power on heavy trains booked at 48 to 50 miles an hour. Latterly, the earlier 4-6-0 engines with six-coupled 5 ft. 8 in. wheels have been much used on this stage, but their wheels were thought to be somewhat too small for the highest speeds, although similar engines with 5 ft. 8 in. wheels have long been doing a great deal of equally fast express duty on the Chemin de Fer du Nord. So the new locomotives have been given wheels actually 2 in. larger than those of the latest four-coupled compounds on the same railway; also larger to the same extent than the six-coupled wheels of Mr. Wilson Worsdell's similar (but non-compound) type on the English North-Eastern, Nos. 2111-2115, and than Mr. G. J. Churchward's "98" and "100" on the Great Western, while 4 in. bigger than the wheels of Mr. J. F. M'Intosh's Caledonian "49" and "50." Judging from the experience of those British types, the new Est engines should be able to run trains of 300 tons and upward with ease at the highest speed officially permitted, viz., 75 miles an hour, and to climb the Vosges gradients of 1 in 125 at well over 40 miles an hour. M. Salomon is to be congratulated on his highly interesting new departure, the result of which will be closely watched in this country.

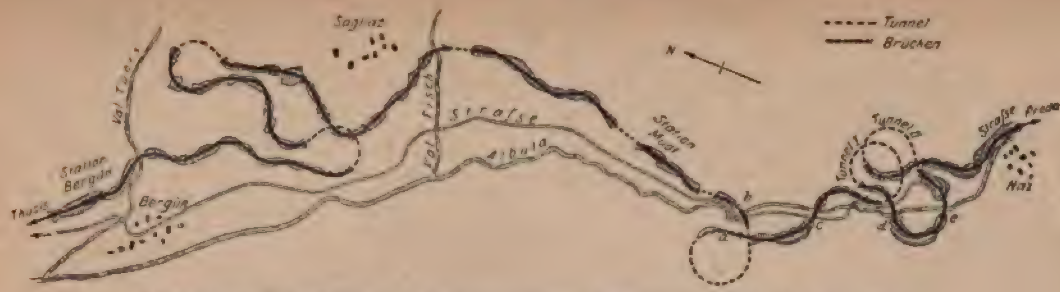
The Latest Departure.

The closing year of the nineteenth century, A.D. 1900, witnessed the latest departure in French locomotive practice in the introduction on the Chemin de Fer du Nord by M. du Bousquet of the Atlantic design for express locomotives, the de Glehn system of compounding being, however, maintained in its entirety. The salient features of M. du Bousquet's new design consisted in reducing the driving-wheel diameter by practically 4 in., viz., from 7 ft. to 6 ft. 8 in., in taking full advantage of the scope offered by the addition of a trailing pair of carrying wheels behind the firebox, for extending the dimensions of the boiler and firebox longitudinally—thus increasing the heating surface to 2,300 square feet, in increasing the steam pressure to 228 lb., and in enlarging the low-pressure cylinders to 22 in. in diameter, while the two pairs of coupled drivers were placed close together in front of the firebox thus midway under the boiler length and with the shortest possible driving-wheel-base. In other words the now-famous Atlantic design of MM. du Bousquet and de Glehn was evolved and its earliest exponent, No. 2.641 started work in 1900, while the sister engine, No. 2.642, was on view in the Vincennes Annexe of the Paris Exhibition. The tale has already been told in these columns of PAGE'S MAGAZINE by the present writer how the brilliant successes of the new type led to its large multiplication on the railway of its introduction and to its adoption also on the French Midi line and finally to an engine of the same type being obtained from M. de Glehn for the Great Western Railway of England.

The Midland Compounds.

Not long ago a description was given in these columns of the new three-cylinder compounds, designed and built at Derby for the Midland Railway, by Mr. S. W. Johnson, the eminent Chief Mechanical Engineer of that line. Also some particulars were added of the fine work done under the writer's personal observation on the very severe section of the Midland line extending from Hellifield to Carlisle. It was mentioned subsequently that the two later members of this class, Nos. 2633 and 2634 were now working up to London with express trains. Some brief account of one of their performances under the writer's own observation, on this section of the Midland Railway, will probably be read with interest. No. 2634 was employed to take the 10.15 a.m. down Manchester Express from St. Pancras to Leicester. The load was extremely heavy. It was officially reckoned as "21 coaches," representing a total weight of fully 350 tons behind the tender. On the first stage, London to Bedford, the engine had to contend with long banks at 1 in 177, 1 in 176, etc. These she ascended readily at a minimum speed of 47·4 to 50 miles an hour. Bedford was reached in 53 minutes 33 seconds, start to stop, the distance being a few yards under 50 miles. The length of 19¾ miles from Luton to the Bedford stop, mostly downhill, was run in the quick time of 17 minutes 7 seconds, a maximum speed of 80·3 miles an hour being attained down the 1 in 200. Starting afresh, the following run of 49½ miles to Leicester was done in 56 minutes 42 seconds start to stop, notwithstanding a delay of 1½ minute through a signal check outside. The net time from London to Leicester allowing for the stay at Bedford, the start and stop there, and the signal check already mentioned, was 105½ minutes for the 99 miles. The second stage includes three trying banks chiefly at 1 in 100 to 1 in 119, 1 in 132 and 1 in 110 to 1 in 160. The minimum rate up 1 in 119 was 40 miles an hour. Such work as this unmistakably "hall-marks" Mr. Johnson's new engines as of the right stamp for service with heavy and fast-timed trains.

C. ROUS-MARTEN.



THE ALBULA ENGADIN RAILWAY—SECTION BETWEEN BERGÜN AND PREDA.

THE CIVIL ENGINEER AT WORK.

Harbour Works for the Great Western Railway.

The Great Western Railway Company will proceed immediately with their scheme for the construction of harbour and other works at Weymouth, for which Parliamentary powers were obtained in 1898. The new scheme will necessitate some heavy engineering work, but when completed the Great Western Railway will have one of the finest harbours in the country, which will admit vessels of all sizes and at any hour of the tide. The present Weymouth harbour is narrow and inconvenient, and as it was found impossible to adapt it to the company's requirements, it is proposed to construct an entirely new harbour of 70 acres in extent by constructing two new breakwaters, one to be thrown out from the Nothe Fort and the other from the new Admiralty breakwater. Inside the harbour two jetties will be provided, together with the necessary wharves and warehouses. An important section of the works provides for a line from the new dock railway along the Admiralty breakwater, which will enable the company to convey coal to the war vessels in Portland Roads with the utmost expedition. A local loop-line is also to be made.

The works which have been carried out for the company at Fishguard Bay will result in a material shortening of the passage to Ireland, the Irish traffic being diverted from New Milford to Goodwick on the south of the bay. From this point to Rosslare the distance is only 54 nautical miles, as compared with the 98 nautical miles of the existing route between New Milford and Waterford. The works have involved the building of a quay at Fishguard Bay a mile in length and 250 ft. wide, while the bay is being protected by a breakwater 2,000 ft. in length.

Dockising the Thames.

Next session when the scheme of the Dock Companies has to go through the Parliamentary mill, it is stated that a novel plan will be brought forward with the object of converting forty miles of the navigable portion of the Thames into one huge dock. To effect this it is proposed to incorporate a Board of Commissioners with power to construct across the River Thames between Gravesend on the one shore and Shadwell on the other a dam, with locks, weirs, and sluices, and other works, and thus to form what is described as the harbour of the Thames, comprising the entire river between Gravesend and Teddington Weir. Under this scheme the Commissioners seek to be invested with powers, privileges, and control now exercised by the Thames Conservators, the Watermen's Company, the Corporation of London, the London County Council, and Trinity House, to re-adjust the tolls paid on vessels and goods entering or clearing from the harbour of the Thames, and generally to control "the harbour of the Thames." The estimated cost of the work, including compensations and other contingencies, is estimated at £3,658,000. The saving claimed to be effected includes £200,000 now spent in dredging the river, £225,000 in time of vessels ascending and descending, and in barging of £185,000.

This opens up a very large question, and at the present time we must be content to give the facts available for what they are worth. Sanitary and other considerations inimical to such a scheme immediately suggest themselves; but it is impossible to formulate opinions on the matter in the absence of more detailed information.

Water for the Naval Base at Rosyth.

Among the schemes which Parliament will be asked to sanction in the forthcoming session is one providing for a large reservoir which is to be constructed by the County Council of Fife chiefly to supply the new naval base on the Firth of Forth. It is proposed to construct the reservoir on a stream called Glenquey Burn, the length being 1,640 yards up the valley. The dam which will retain the waters will be 266 yards long, and in connection with the works there will be road diversion, etc. The County Council also wish to absorb some existing water undertakings, and to supply other areas in addition to the naval base.

Peterhead Harbour Works.

Messrs. Coode, Son and Matthews, the engineers-in-chief of the Peterhead Harbour works, report that during the year 1902-3, terminating at the end of last March, the breakwater was extended ninety lineal feet. A portion of this length, or 30 ft., represents the part of the structure which has received an additional width of 10 ft. An extension of 30 ft. has also been made in getting in the foundation course, and the rubble mound has been added to, and partly levelled up over a length of 650 ft. in advance of the superstructure. During the year the daily average number of men employed on the works was 340; of these 167 were convicts. It is considered that, taking into consideration the widening of the structure, good and substantial progress has attended the execution of the works.

Forthcoming European Canals.

According to a report of the United States Consul at Trieste, canals appear to be regaining the importance in Europe which they have lost for many years. In the last ten years Germany has expended vast sums on inland navigation; in the course of the next decade Austria is to devote about £13,000,000 to the same object; and Italy has just begun to deal with large schemes of a like nature. An Italian commission has recommended the establishment of a network of navigable watercourses, 2,112 miles in length, in the northern part of the kingdom, the region having already 1,677 miles of navigable rivers and canals, which are to be connected by a system of auxiliary canals. The cost is estimated at about £4,500,000, but the actual cost will be reduced by a third, by the sale of water power and of water for agricultural purposes. The

main line of the proposed system would be a canal from Venice by Milan to Turin; another would connect Milan and Bologna, and a third Bologna and Venice. A navigable waterway would also be made from Venice to the Austrian frontier, for which purpose three existing rivers would be utilised.

The Albula Engadin Railway.

In a previous issue of PAGE'S MAGAZINE an article on the Albula Engadin Railway was illustrated with some photographic reproductions which gave an excellent idea of the difficulties which were encountered by the engineers responsible for the line. A paper on the subject contributed by Mr. H. Cox to one of the German technical societies includes plans and sections which further emphasise the difficult nature of the ground. One of these, showing the section from Bergün to Preda, with its characteristic loops, is here reproduced.

The most serious difficulties of the whole line were encountered on the Sils to Tiefenkasten section, which comprises the greatest number of tunnels and the largest viaducts. This section is 12·5 kilometres (7·8 miles) in length, of which 4,106 metres (2 miles 970 yards), or 33 per cent. are in tunnel, and it includes as many as twenty-seven viaducts having a total length of 1,300 metres (1,422 yards). The steepest gradient on this section is 25 millimetres per metre (1 in 40). The estimated cost was 275,000 francs per kilometre (£17,700 per mile). The actual cost of the first contract of 5·5 kilometres (3·4 miles) in length exceeded the estimated cost by 200,000 francs (£8,000) in round numbers, and there was a similar excess in the case of the fifth contract, which shows that, taken altogether, the estimates were comparatively accurate.

Mr. Cox mentions that in the construction of the Albula Tunnel a great quantity of water had to be dealt with at both ends. At the north end the water increased in the first kilometre until it reached a quantity of 75 litres (16·5 gallons) per second. At 1,006 metres (3,300 ft.), in April, 1900, it rose to 300 litres (66 gallons) per second, and then remained practically constant at 215 litres (47·3 gallons) per second until the middle of the tunnel was reached. The temperature of the water was only 6 deg. C. (43 deg. Fahr.). Brandt drills were used at both ends. The average progress at the north end with two drills was 90 metres (98·4 yards) per month, and at the south end with three drills 130 metres (142 yards) per month. As a general rule ten holes were drilled in any area of 7 square metres (75·35 sq. ft.), that is to say, the section of the heading. Each of these holes was 1·40 metre (4 ft. 7 in.) long, and contained a charge of 25 to 35 kilograms (55 to 77 lb.) of gelatine. Each drill had to be renewed after boring to a depth of 16 centimetres ($6\frac{5}{16}$ in.). A junction was effected on the 29th May, 1902.

The Irrigation of the Nile Valley.

It is difficult to estimate the practical benefits that must accrue to Egypt from the great dams constructed across the Nile. Sir Benjamin Baker, speaking at York on a recent occasion, remarked that "By means of the Assouan reservoir the flow down the river was supplemented in June to the extent of 20,000,000 tons of water per day, which practically doubled the available supply at the most critical time for the irrigation of summer crops. Without this discharge of water great difficulty would have been experienced in saving the cotton crops. The irrigation of rice, which had been prohibited in previous years, was again allowed, and land for planting the durah crop was irrigated a month earlier than had ever been the case before. In Middle Egypt 170,000 acres of basin land had been converted for crops, and each year more would be taken in hand, up to a final total of about 350,000 acres in two years. This land increased in rental value £3 per acre and in actual value £30, while the cost of all drainage and irrigation works was only £4 per acre. The result was an annual increased rental of upwards of half a million sterling on these converted basin lands alone." There can be little doubt but that there are openings for further engineering enterprise in Egypt of a most important kind, more particularly in the development of the Sudan. Those who are interested in the subject cannot do better than peruse the article on the Irrigation of the Nile Valley which appears in another part of the Magazine.

Westinghouse Gas Engines and Motors.

The Power Gas Corporation, Ltd., has recently placed an order with the British Westinghouse Electric and Manufacturing Company, Ltd., for the supply of two 250-h.p. 3-cylinder single-acting Producer Gas Engines, solid coupled to direct current generators of equivalent power. The engines will be installed at Dudley Port. The same company is supplying two 25-h.p. direct-current motors to Messrs. R. Waygood and Co., the well-known lift manufacturers, for installation at one of the stations on the Midland Railway.

Oporto Drainage System.

Messrs. Hughes and Lancaster, of 47, Victoria-street, have been successful in securing in open competition a contract to provide the City of Oporto with a complete drainage system. The firm will be required to lay between 60 and 70 miles of drainage under Oporto, and to construct numerous large ejector stations, the separate system being adopted, in conjunction with Shone ejectors. The sewage will be automatically raised by compressed air, rendering the aid of gravitation unnecessary. Our Houses of Parliament are drained on this plan. Oporto has an estimated population of nearly 120,000.

New Destructor Plants.

The Horsfall Destructor Company, Ltd., of Leeds, have recently shipped two important Destructor Plants to South Africa, for the cities of Bloemfontein and Durban. Among the new Destructors upon which the company is at present engaged may be mentioned plants for Folkestone, Bromley, Chiswick, Swansea, Batley, Stourbridge and Gosport. Several of these destructors will furnish power for electric lighting, sewage pumping, etc., in addition to the sanitary disposal of refuse.

Sewage Disposal.

An instructive paper on sewerage and sewage disposal was read by Mr. C. T. Cuss at a recent meeting of the Junior Engineering Society. He concluded with references to the three reports of the last Royal Commission, an important point in which is the Commissioner's statement as to the inadequacy of existing laws. The protection of our rivers and their sources from pollution is stated to be a matter of such grave concern as to demand the creation of a Supreme River Authority, with a view to prevent the recurrence of such disasters as that at Maidstone. The paper was illustrated by diagrams and apparatus. Mr. Hamp, borough surveyor, congratulated Mr. Cuss on his very able paper, remarking that it was most difficult to make accurate allowances for the outfall of a sewer owing to sudden heavy rainfalls. He paid a tribute to the efficacy of automatic syphons, having found their use very satisfactory at Swindon.

LIQUID FUEL AND ITS POSSIBILITIES.

THE important experiments made by Sir Andrew Noble at Elswick, and the attention which is bieng given to the use of liquid fuel by the Naval Department of the United States, are bringing this question into greater prominence than ever, and Mr. William H. Booth's careful survey of the theory and practice of Liquid Fuel and its Combustion,* therefore makes its appearance at an opportune time.

The author remarks that the successful combustion of liquid hydrocarbon is but an extension of the principles necessary for bituminous or hydrocarbon coal. The difference is that coal is burned partly upon the grate, and air, to burn the hydrocarbon distillates cannot well be introduced from below, as it can with liquid fuel which is burned in a floating condition, and can be fed with air from below very easily. The difference is but one of degree, but with liquid fuel the fact that all the fuel is floating, and would produce a specially foul black smoke under the conditions in which coal is burned, has compelled the adoption of means that ought to be adopted with coal-fired furnaces. An effort has been made to connect two practices, for in the present state of liquid fuel supply it is more than probable that its use will be parallel with the use of coal, especially in dealing with the sudden and high load peaks of electric stations. Liquid fuel cannot be universal unless the supply increases to many times what it is at present, and this points to a good future for the mixed system of firing, oil and coal being burned together in the same furnace.

An interesting chapter is devoted to examples of liquid fuel carriers by rail and sea. The tank wagon by Messrs. W. R. Renshaw and Co., Ltd., shown in the accompanying illustration, is considered by the author to be the best for the transport of liquid fuel by rail. It has a capacity of 2,800 gallons of oil at a specific gravity of ·82, and is one of ninety built for the Shell Transport Company. The shell plates are made in one length, $\frac{3}{16}$ in. thick, and the dished ends are $\frac{3}{8}$ in. thick. The manhole is provided with a screwed cover, thereby forming an air-tight joint. The outlet has a plug valve worked by a handwheel at the top of the tank inside the manhole, and to the stool in which this valve rests is connected a wrought-iron branch tee-piece giving two outlets, one on either side of the wagon. These have each a $2\frac{1}{2}$ in. gun-metal sluice valve, and the end of the pipe is covered by a gun-metal cap to protect the screw to which hose coupling may be attached for discharging the oil. The whole of the riveting is done by hydraulic and pneumatic machinery, and the tanks must be tested to 20 lb. per square inch pressure, and must be absolutely watertight before being passed. The steel underframe should be of exceptional strength, a special feature in the wagon illustrated being the method by which the sole bars are joined to the headstocks, both by flanging of the bars and by cover plates. The oil tank is attached by four side brackets to the framing, and is also supported at each end against the headstock by blocks of timber. There is a longitudinal stay plate between the two dished ends and a pair of diaphragm or swash plates to distribute surging stresses throughout the whole tank structure. Made of tough steel plate of boiler quality, such a tank should bear a good deal of rough usage or collision without failure.

The author is to be congratulated on producing a work of such completeness, and on rendering the subject so attractive. In Part I. will be found a careful exposition of theory and principles; Part II. presents selected practical applications of the use of oil fuel, while Part III. contains many valuable appendices, and there are about 120 excellent illustrations.

* "Liquid Fuel and its Combustion." By W. H. Booth. 24s. net Archibald Constable.

TANK WAGON, BY MESSRS. W. R. RENSHAW AND CO., LTD., FOR LIQUID FUEL TRANSPORT.

GUNS FOR COAST DEFENCE.

A KRUPP 12-IN. COAST DEFENCE GUN IN ROTATING TURRET.

The projectiles weigh from 771 lb. to 981 lb., and their initial velocity attains 3,038 foot seconds. The maximum range at 22 deg. of elevation is 21,872 yards, and at 45 deg. of elevation 27,340 yards. The turret is rotated and the gun loaded by hand power, but either electric or hydraulic power can be applied, if desired.

A 3-IN. 12-POUNDER LANDING EQUIPMENT BY MESSRS. VICKERS, SON AND MAXIM.

Weight of Gun, 4 cwt. 14 lb.; ditto of Carriage, 7 cwt. 3 qr. 4 lb.; ditto of Limber complete (with 36 rounds) 13 cwt. 6lb.; Muzzle Velocity (foot seconds), 1,600; Weight of Projectile, 12½ lb.

The Limber consists of a steel frame, supported on the axle by brackets and springs. At the rear of the frame is a hook for attaching the gun carriage when travelling, and the front is fitted to receive the pole, which is attached to the axle by means of a bolt.

NOTES ON THE WESTPHALIAN COAL FIELD.

BY

DAVID A. LOUIS, F.I.C., M.Inst.M.E., M.A.I.M.E., F.C.S.

The present article covers the various systems of winding in vogue. The previous article described the geology of the district, methods of working the coal, and means of transport.—Ed.

II.

In some instances, as at Rhein-Elbe III., one of the most magnificently equipped pits in the district, special forms of pit frames have been introduced. The two shafts Rhein-Elbe I. and II. have been working the upper seams since 1861, and it was intended to use them to work the lower seams, but since improved methods had rendered some 25,000,000 tons of coal in the thinner and neglected upper seams available, it was decided to utilise the old shafts to work this out, and to sink a new shaft, with all new appliances, to work the lower beds in which there are seventeen workable seams, varying from $27\frac{1}{2}$ in. to over 5 ft. in thickness, representing some 45,000,000 tons of coal on this single property. The new shaft, designed to draw 3,000 tons of coal a day from three levels, is 2,625 ft. deep, and about 18 ft. in diameter, is arranged for double winding, a main winding on the Koepe system for the deepest level, and a supplementary winding, with cylindrical drum to serve the two other levels; the supplementary winding is arranged at right angles to the main winding. The usual German design of frame was not considered equal to do this work, so the four-legged form, illustrated in fig. 5, has been adopted, which not alone suffices to carry the weight and resist the strain of winding, but also relieves the shaft walls from pressure. The frame is $98\frac{1}{2}$ ft. high to the hubs of the pulley, is constructed of plate girders, to present less surface to oxidization, and is provided with a travelling crane above. The shaft housing, which is in two stories, is constructed within the main frame on an independent frame work. The total weight of this structure is well over 390 tons, and the loads it will have to bear are :—

In the Main Winding.

Cage complete ..	$4\frac{1}{2}$ tons.
8 tubs	$2\frac{4}{5}$,,
8 loads	$5\frac{3}{5}$,,
875 yards of rope	$10\frac{2}{5}$,,

In the Secondary Winding.

Cage complete ..	$3\frac{1}{2}$ tons.
4 tubs	$1\frac{2}{5}$,,
8 loads	$2\frac{4}{5}$,,
875 yards of rope	$4\frac{4}{5}$,,

The weights, heights, and capacity of some pit-head gears at other collieries are given below :—

Table C.

Mine.	Height in feet.	Weight in tons.	Useful load in wagons of 10 cwt.
Monopol	87	73	8
Ewald & Minister Stein	105	93	12
Preussen	$124\frac{2}{3}$	107	8
Kaiser Friedrich ...	144	155	8

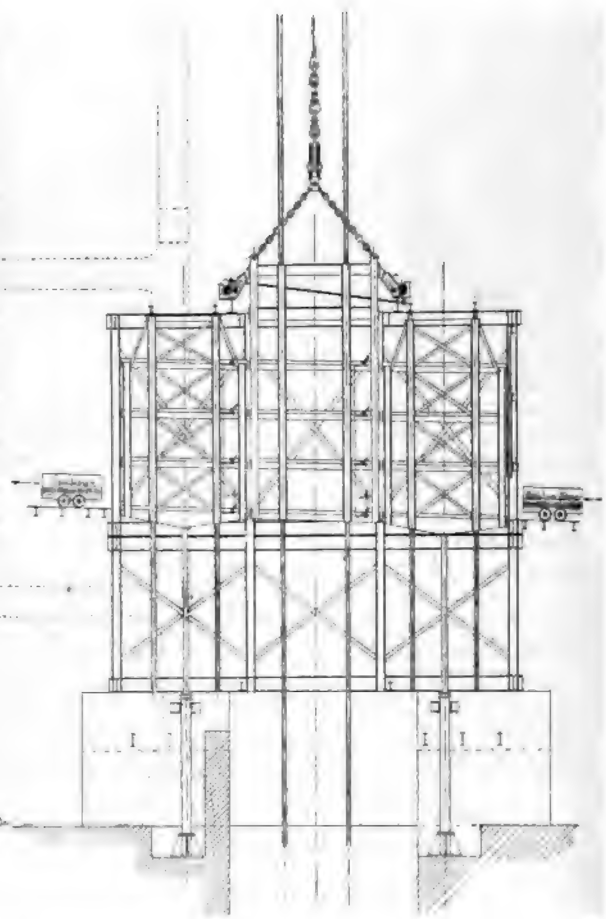


FIG 6. TOMFSON BANKING ARRANGEMENT—SIDE VIEW.

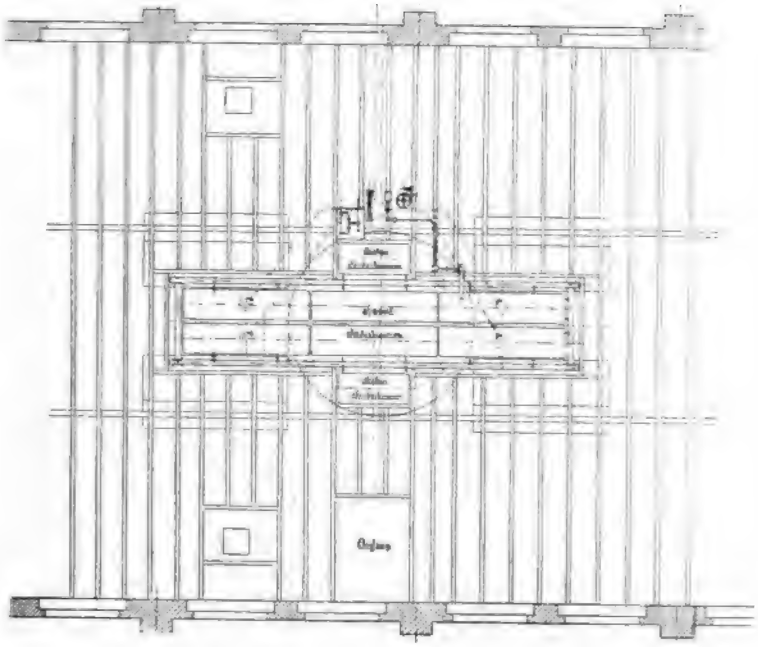


FIG. 7. TOMPSON BANKING ARRANGEMENT—PLAN.

All sorts of cages are in use, a great many carrying four tubs on two or four stages, some six tubs on three stages, others eight tubs on four stages, and a few even eight tubs on eight stages, but the most approved present practice is eight tubs, in couples, end to end on four stages. In some pits, Prosper II., Shamrock IV., for example, double winding is practised in a single shaft, which has the effect of greatly increasing the output, as much as 4,500 tons have been drawn in two eight-hour shifts, the best single winding has not given half that quantity. Some of the mines, only have a single landing-floor, others have several, but to avoid the inconvenience of multiplying landing-floors, and to save time, Tomson's banking arrangement has been introduced in some of the mines, and, so far, has worked well. It is a modification of Fowler's system, and an illustration of it was given on page 227 in the March issue of this magazine, but a word or two may now be said about it here. It consists of four auxiliary cages (figs. 6 and 7) each with as many decks as the main cage, resting on plungers in hydraulic cylinders two side by side on each side of the guide frame of the shaft, and installed at the surface and at the pit bottom. The decks are inclined, and the arrangement is such that when the main cage is in position for changing tubs, three cages are in line (fig. 6), one empty auxiliary cage in front ready to receive the tubs, which run off the main cage as soon as the stops are released, whilst a full auxiliary cage behind, by the movement of a single lever, discharges its load into the main cage. Automatic stops on the main cage, operated by the tubs themselves, arrest their further progress. During the wind the auxiliary cages are charged and discharged. The two cages on the same side of the shaft are connected to one another by a chain passing over a pulley at the top, whilst the corner cages on opposite sides of the shaft are connected diagonally through the hydraulic cylinders. The full tubs are withdrawn from the lowest deck of one cage, while empty tubs are charged on the upper deck of the opposite corner cage; the hydraulic valve is opened and the superior weight of the full cage in sinking, forces up the empty tub cage, but as soon as the next deck is at the level of the floor, the hydraulic valve is closed, the full tubs are withdrawn from their deck, and the empties charged on to the vacant deck of the other cage: these operations are repeated until all the decks are discharged or charged, and the loaded cage is in position behind the shaft, whilst the top deck of the cage just discharged is on a level with the floor and ready to receive its charge of empties. If the weight of the full tubs is not sufficient to raise the empties, an auxiliary hydraulic power is available. In the meantime, the overhead chain from the cage with the full cars has, during the descent of that cage, drawn up the empty cage alongside, so that there is a cage full of empties at the back and an empty cage in front of the shaft, both in position for immediate action as soon as the main cage is at rest on the automatic keps. At the pit bottom the operations are similar, but, of course, follow in the reverse order. The operations connected with the manipulation of wagons on four decks occupy less than a minute with three men at the surface, and four underground. In one pit, 1,720 ft. deep, the wind lasts 56 seconds, the changing 15 seconds, together 71 seconds, which, with 4½ tons a time, represents about 220 tons of coal an hour. Figs. 6 and 7 show clearly this ingenious arrangement, with

FIG. 5. RHEIN-ELBE COLLIERY FRAME.

the hydraulic connections and the valve gear. Fig. 6 is a side view, and shows the opposite auxiliary cages in position. Fig. 7 is a plan indicating the order of the arrangement about the shaft which is represented by the large circle. The writer was much struck with the smooth and regular working of this arrangement.

The shafts in Westphalia, for reasons already stated, are very expensive, and therefore every effort is made to utilise them as much as possible. Double winding and the Tomson device are two modes of achieving this end. Another instance of a remarkable effort in this direction is that presented at Neumühl Colliery, when, in order to render the whole area of the upcast shaft available for ventilation and at the same time useful as a winding shaft, the entire shaft house has been constructed air-tight, presenting a total surface of 36,200 square feet to the outer atmosphere. This structure, illustrated in figs. 8, 9, 10, 11, and 12, encloses the whole banking floor and tipplers, as well as the guide frame and winding pulleys, the only direct connections with the external atmosphere being the holes in the pulley casing through which the winding ropes pass. These holes being only slightly larger than the ropes are lined with wood, and occasion only an inconsiderable leakage. Admission to this pit top is only obtained through air-locks, all the ordinary banking operations are conducted within the area of reduced atmosphere, and no inconvenience is experienced: certainly, none was felt by the writer when inspecting the arrangements at Neumühl. The arrangements, too, are such that material can pass out, but no air can pass in. Round coal, when required dry, is tipped into a shaking screen (b2, in the figs.): the smaller pieces pass into an air-tight hopper (E, in the figs.), whilst the round coal passes into a drum with an opening above in the reduced atmosphere, and an outlet below in the outer atmosphere; within the drum, 8 sheet-iron blades are arranged radially on a central shaft, and fit air-tight at the casing of the drum (h, fig. 11); and there are always two of these blades at least, on each side of the openings, in contact with the casing. These blades revolve and carry with them the coal which has been tipped in, delivering it below on to the picking belt in the outer air. In the case when coal may be delivered wet, it is screened in the usual way, and then falls into a water tank, which extends both sides of, as well as below the walls of the building forming a water seal, as seen in fig. 10, c. The coal is picked out by a conveyor on to the picking belt. The coal, where separation is not desired, is tipped into bunkers closed by a door above

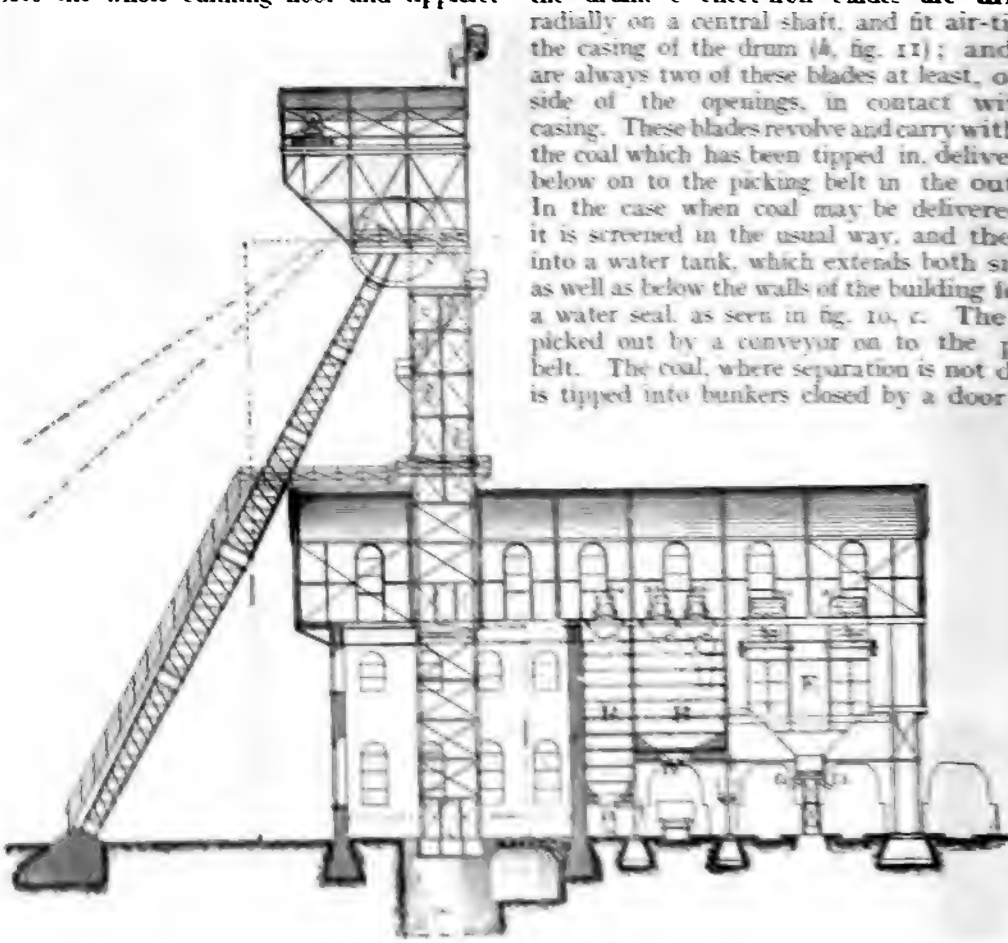


FIG. 8. PIT HEAD AT NEUMÜHL COLLIERY.

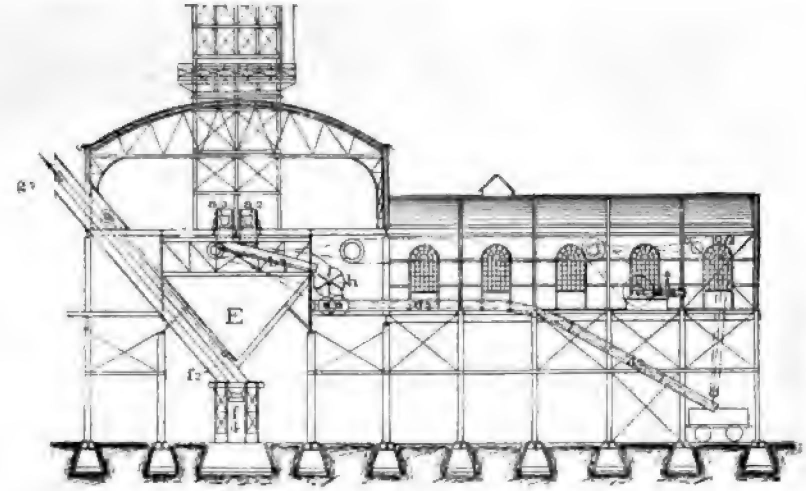


FIG. 11. SCREENING AND PICKING DRY COAL, NEUMÜHL COLLIERY.

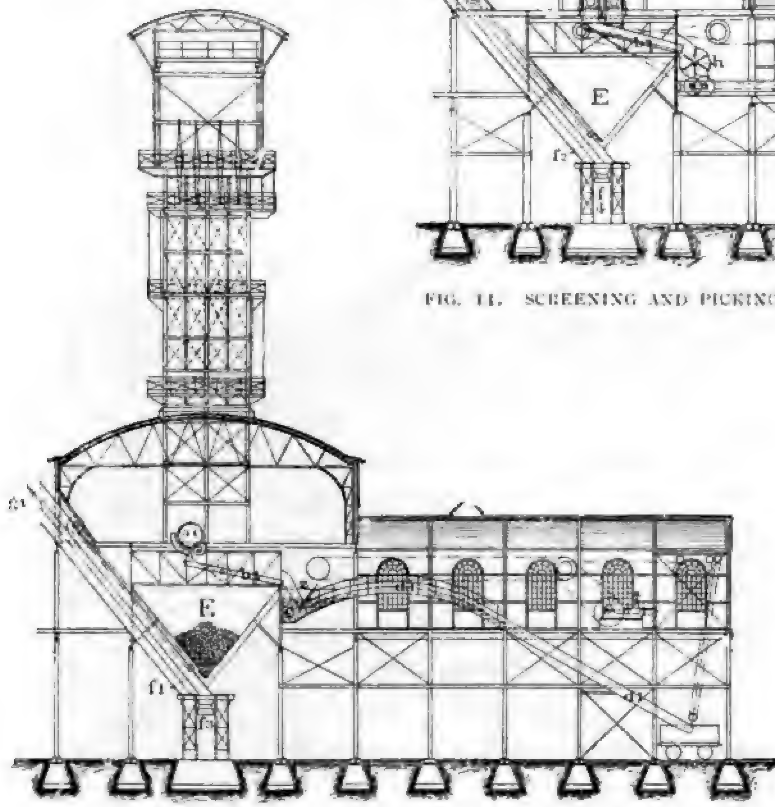


FIG. 10. SCREENING AND PICKING WET COAL AT NEUMÜHL COLLIERY.

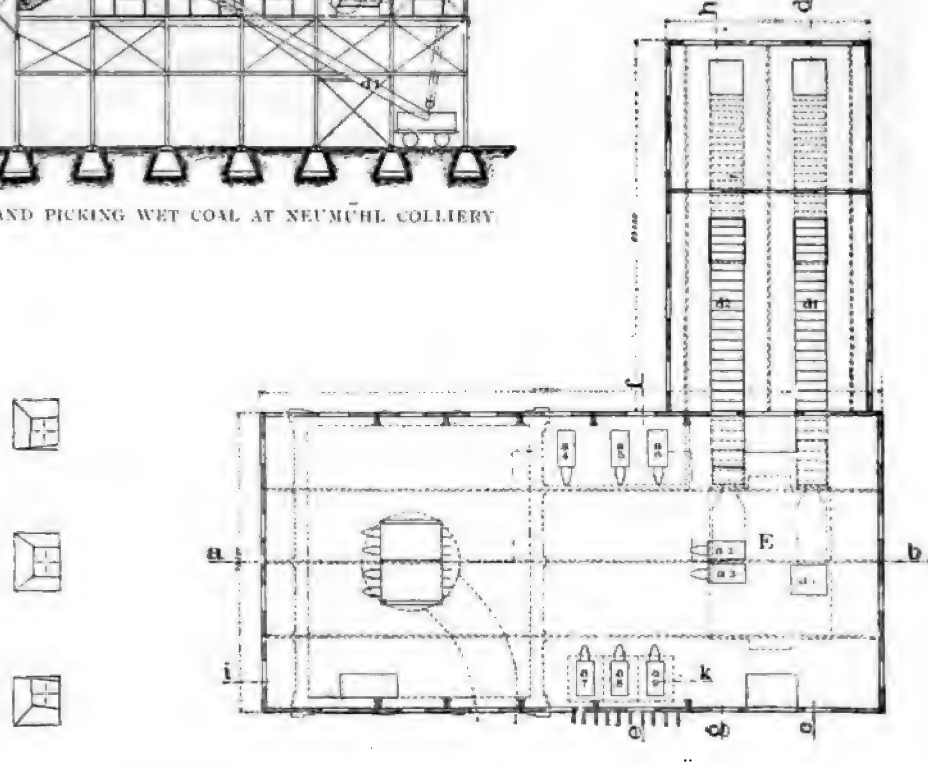


FIG. 9. PLAN OF PIT HEAD ARRANGEMENT AT NEUMÜHL COLLIERY.

SHAFT, SORTING AND WASHING BUILDINGS, NEUMÜHL COLLIERY.

and one below, which are never open at the same time (R, fig. 8), that is while the upper door is open no discharging takes place below, and *vice versâ*. Waste is treated in the same way, being tipped into chambers which are really air-locks. There is a sufficient number of these chambers to obviate the necessity of opening the upper door while the lower or discharging door is open. The small coal hopper is also closed with doors, and, as indicated in fig. 11, there are arrangements for discharging the contents, and elevating them to the washery. It was very interesting to watch this arrangement working. All went smoothly and well, just as if the ordinary state of things obtained, although there was a current of 210,000 cubic feet a minute, and a depression of about 4½ in. But, in spite of all, the leakage only amounted to well under 5,000 cubic feet.

Turning now to the actual winding, rail guides and round ropes are most in favour, whilst great diversity is observable in the engines and drums at the various mines, as might be expected in a field that has been in work a century. Twin engines, with narrow cylindrical drums of large diameter (5 ft. by 20 ft.) being the most common; compound engines are also in vogue, although it is not considered good practice in shallow shafts. Expansion is only slightly adopted in winding, and condensation not at all, except with central condensers, which are very much in demand just now in Westphalia. There are a few spiral drums to be seen, and Tomson's divided spiral drum is in use at the Preussen Collieries; this was illustrated in our issue of December, 1902, but fig. 13 is another view of this interesting winding engine, which, it will be remembered, will wind from three depths, 2,625 ft., 3,281 ft., and 3,937 ft., respectively, and that the useful load to be drawn from each depth will be 8 tubs, or 88 cwt. of coal, from the smallest depth; 6 tubs, or 66 cwt. of coal, from the intermediate stage; and 4 tubs, or 44 cwt. of coal, from the greatest depth; the maximum speed will be 72 ft. a second, and the mean speed 33 ft. to 40 ft. a second. The cylinders of the engine are 32$\frac{3}{16}$ in. and 45⅕ in. in diameter, and the stroke is 102$\frac{3}{16}$ in. The drums are each 18 ft. diameter at the smaller end, 33 ft. at the larger, and 11⅓ ft. in width.

But the style of winding engine most in favour is the twin-compound horizontal engine, with cylindrical drum, or sometimes, as at Scharnhörst, with spiral drum. The engines in this case are twin and tandem compound made by Friedrich Wilhelm, A.G., zu Mülheim a.d. Ruhr, with cylinders 27½ in. and 37½ in. respectively, and 63-in. stroke. The drum is 19 ft. in diameter at the smaller end, 26¼ ft. at the larger, and 5 ft. 11 in., with 150 lb. boiler pressure. These engines can wind a total load of 16⅕ tons, including rope, etc., and a useful load of 4⅗ tons from a depth of 1,988 ft., at an average speed of 32½ ft. a second. The following numbers refer to a type of engine which is used and made by the Gutehoffnungshütte, A.V., of Oberhausen. It is also twin-tandem, and for a total load of 19 tons, including 7⅓ useful to be wound at 1,800 ft. at a mean speed of 39 ft. per second, with a 17½-ft. cylinder drum, 11 ft. 10 in. wide, has the following chief dimensions: cylinders, 2 ft. 3½ in. and 3 ft. 5⅝ in.; stroke, 5 ft. 7 in.; and would work at a boiler pressure of about 160 lb. The Koepe system of winding is in good favour, and wherever introduced has given good results. The installations are mostly steam driven, but electricity has also been applied with

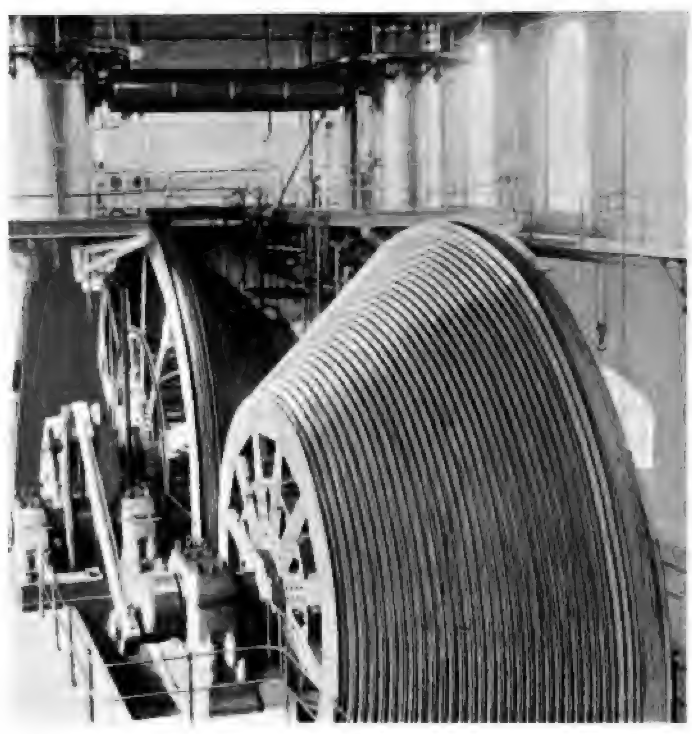


FIG 13. TOMPSON WINDING ENGINE AT THE PREUSSEN COLLIERIES.

success. Rhein-Elbe has a recent steam winding plant on Koepe system, made by Friedrich Wilhelms Hütte, Mülheim A.R., to wind a total load of $23\frac{3}{16}$ tons inclusive ; $5\frac{3}{8}$ tons of coal from a depth of 2,625 ft., at a mean speed of $32\frac{1}{2}$ ft. per second. The engines are twin horizontal engines, with $25\frac{1}{2}$-in. cylinders and 5-ft. 11-in. stroke, and work with 120 lb. steam. The winding engine at No. 1 shaft, Preussen II. Colliery of the Harpener Mining Company, of Dortmund, may be taken as an example of an electrically driven Koepe plant. The Koepe bobbin is $20\frac{1}{3}$ ft. in diameter, and the armature of the motor is keyed on to the same shaft. This was installed by the Allgemeine Electricitäts A.G. It is a three-phase engine ; the current is supplied to the fixed portion of the dynamo at a voltage of 2,000, and is obtained from a central station, in which there are three three-phase generators, each of a capacity of 550 kilowatts when running 94 revolutions a minute. They are driven by an 800-h.p. twin-coupled horizontal engine.

There are also drum engines driven electrically, and there are, of course, other makers besides the Allgemeine Electricitäts A.G., and other types of electrically driven winding engines, but the one example must suffice here.

tons useful load at a speed of from 40 ft. to 60 ft. a second from a depth of 2,460 ft. Each valve box contains an admission, an exhaust and a relief valve, the latter intended to come into play when the pressure in the box gets too high and to return the steam to the supply system. There are also external safety valves, and they, as well as the spindles of the geared valves, which project through the covers of the valve boxes, are in the view of the engineman. These valve spindles connect with the gearing, which is operated by a special engine readily worked by the man with one hand. If required high-pressure steam can be admitted to the low-pressure cylinder ; moreover, there is a control valve between the low-pressure cylinder and the receiver, and this and the throttle valve being connected can be worked by the same lever. The engineman hence has to watch and control the steam. There is an indicator to show the position of the cage in the shaft, which rings a bell when the cage is nearing the top, and puts on the steam brake in case of an overwind ; there is a speed indicator connected with a clockwork tell-tale, which graphically records the speeds of each wind ; this indicator, moreover, it the engineman neglects to slacken at the proper moment, applies the brake. Both indicators and their safety appliances are worked from the drums, and are independent of the steam supply gearing. The drums are cylindrical, with a diameter of about 28 ft., a width of above $6\frac{1}{2}$ ft., capable of accommodating 2,790 ft. of rope. They are provided with four brake blocks, which can be applied by hand or by steam, or as already noted automatically.

The cylinders, valve, boxes, etc., are lagged with non-conducting material and covered with burnished sheet metal. Most of the points noted can be seen in the illustration.

TABLE D.

	Tons. Useful load.	Depth in fathoms.	Speed. ft. per sec.	Cylinders, diameter.	Stroke.	Drums. Measurements in feet.
Gutehoffnung—Horizontal twin-tandem...	$7\frac{1}{8}$	300	39	$27\frac{1}{2}$ and $41\frac{3}{8}$	67	$17\frac{1}{2}$ by $11\frac{3}{8}$; cylindrical
Preussen II.—Vertical compound ...	$4\frac{2}{3}$	438				
" " " ...	$3\frac{1}{3}$	547	33—40	$33\frac{1}{2}$ and $45\frac{1}{5}$	$102\frac{1}{3}$	18 and 33 by $11\frac{1}{3}$; Tomson's
" " " ...	$2\frac{1}{5}$	656				
" Three phase	$2\frac{1}{5}$	400	52	...	...	$19\frac{2}{3}$; Koepe
Tamarach—Four-cylinder diagonal ...	6	1,000	70	34	..	25 ; spiral

In Table D some data in connection with the Westphalian winding engines are given, and that of the Tamarach, in America, is cited for comparison.

GUTEHOFFNUNGSHÜTTE WINDING ENGINE.

The engine of this type, illustrated in the December number of PAGE'S MAGAZINE, is a horizontal twin-tandem engine. The high-pressure cylinders have a diameter of nearly $33\frac{1}{2}$ in., the low-pressure cylinders of $47\frac{1}{4}$ in., the stroke is $78\frac{3}{4}$ in. ; the working steam pressure 8 atmospheres, and the duty to raise 4[illegible] metric

(To be continued.)

SUSPENDED RAILWAY TRIALS.

SPECIALLY CONSTRUCTED HIGH-SPEED EXPERIMENTAL CAR.

A BRIEF ACCOUNT OF THE HIGH-SPEED TRIALS ON THE BARMEN-ELBERFELD ELECTRIC SUSPENDED RAILWAY.

In Page's Magazine some account was recently given of the Barmen-Elberfeld Electric Suspended Railway. At this time the whole of the line had not been opened, a certain portion being reserved for some high-speed trials. These have just been brought to a successful conclusion.

It is not intended to run the trains at speeds exceeding forty miles an hour, as the stations are too frequent. It may be noted, however, that Drs. C. Koepcke, A. Goering, and V. Borries, in a recent report on the Langen system, state that, if suspended railways were constructed above the existing ground railways for express passenger service, *speeds of up to 200 kilometres on curves of 500 metres, and of 135 kilometres on curves of 300 metres, could be attained.* During the past few weeks some very interesting high-speed trials have been carried out on the Barmen end of the line.

The trial car differs from those in ordinary service on this railway, the motor being placed above the roof, below the rail and supporting girders, both wheels of each bogie being drivers, for which bevel gearing is employed. This design permits of an arrangement of the car body and bogie trucks, so that their centres of gravity lie in a vertical plane passing through the rail, thus avoiding even the small oscillations which occur with the older type of car, due to the eccentric arrangement of the loads necessitated by the position of the motors. The wheels of the new car are 2 ft. 6 in. in diameter, and each is driven by a continuous current series-wound motor of 50 ampères normal capacity at 600 volts. The bevel-gearing reduces the speed in the proportion of 1·2, and the motors are regulated by series parallel controllers. Two motors are sufficient to give the car a speed on the level of thirty-seven miles per hour, with a total current of 100 ampères at 480 volts at their terminals.

The speeds attained were calculated from the time taken to traverse a length of 200 metres, which was checked by a stop watch. In the presence of representatives of the German Government a mean speed of forty miles per hour was reached, and at a subsequent trial forty-four miles.

The above figures are those of the mean speeds, the maximum being greater owing to the length of line available for the trials being so short that the motors were still accelerating on the measured distance.

The maximum speed was attained with a total current of 170–580 volts at the motor terminals; according to the motor diagram, the speed was about forty-seven miles per hour.

The engineers reported that, with more powerful motors, and with a line designed for high speeds, there would be no difficulty in working at more than double the speed attained at these trials. The cars ran quietly and smoothly, and the passengers experienced no inconvenience.

SOME MODERN FIRE APPLIANCES.

ILLUSTRATIVE OF THE INTERNATIONAL FIRE EXHIBITION AT EARL'S COURT AND *À PROPOS* OF THE FIRE PREVENTION CONGRESS REPORT.

BY

GEORGE ARMISTEAD.

The previous article dealt with the work of the Fire Prevention Committee, and described some of the principal English-made Fire Appliances exhibited at the Earl's Court Exhibition. In the present article some of the principal foreign fire-engines and escapes are considered. Other English exhibits, electric fire-alarms, etc., will be dealt with in a subsequent article.—ED.

II.

A good deal of enterprise was shown by the foreign makers of fire-extinguishing appliances, whose exhibits greatly added to the interest of the Earl's Court Exhibition, and were, in not a few cases, found to merit the Exhibition Gold Medal.

The gas fire-engine of the Kuhlstein Wagenbau, shown in the accompanying illustrations, is fitted with everything necessary for extinguishing small outbreaks of fire. In the case of more serious outbreaks, it can be used pending the arrival of the steam fire-engine, the water-tank being ready for instant use, with a water store of 900 litres. The two steel cylinders under the water-tank, each with a capacity of 37.5 (37½) litres, are filled with compressed air, by means of which a pressure of eight atmospheres is brought to bear on the water-tank. In this way water can be thrown to a height of 30 metres. In the immediate front part of the vehicle there is a seat for the driver, and behind it a *dos-a-dos* seat for the use of six firemen. Directly in front of the water-tank there is an iron-covered space with waterproof sailcloth at the sides. This contains four rolls of hose, and on each side one hose-reel with hose. On the top of this space is kept a "jumping-sheet," and on the left side a reel with hose for the life-saving apparatus. A box attached to the front part of the engine contains lists of the street hydrants. At the back lie the two large pressure leather pipes for the steam fire-engine, one on each side of the vehicle parallel to the water-tank. Under the water-tank an arrangement has been made for the storage of two hooks, three telescopic ladders, and two iron boxes. In one of the latter the smoke helmet

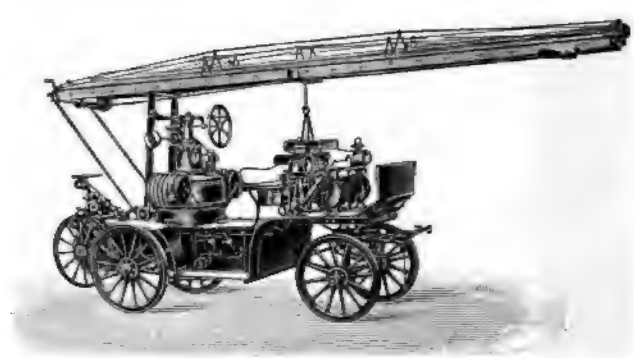
THE GAS FIRE-ENGINE OF THE KUHLSTEIN WAGENBAU.

A FRONT VIEW OF THE ENGINE.

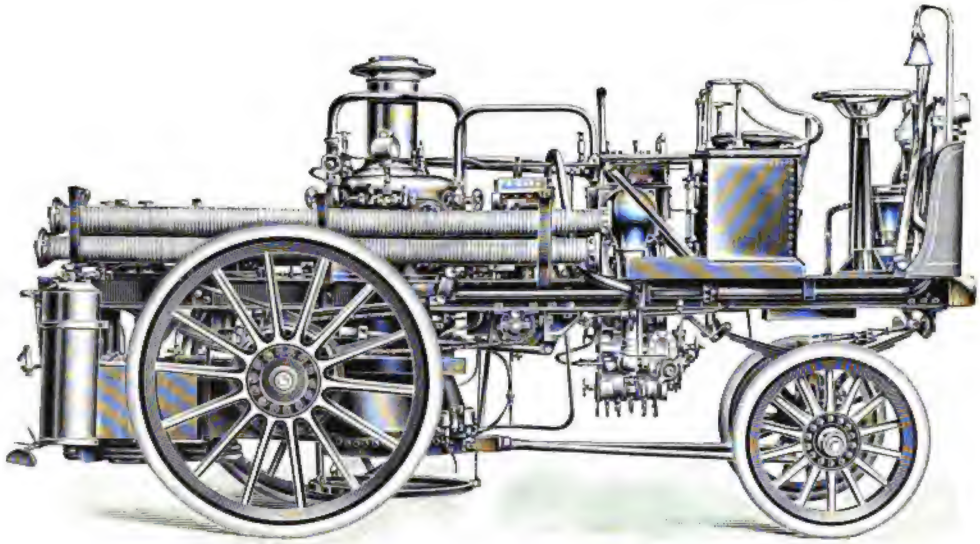
and the life-saving apparatus are stored. On the platform behind the water-tank are two seats for firemen. In the centre, under the vehicle there are two iron boxes which are filled with coal for the steam fire engine. There is also an iron box on the front carriage between the two springs, which contains medicated bandages. The vehicle is almost entirely constructed of iron, steel and brass, and is fitted with patent mail axles.

The frame of the automobile fire-engine shown by the Waggon- und Maschinenfabrik A. G. of Bautzen, and here illustrated, consists of two lateral U-irons, which rest on long roller-springs, and are thus connected with the axles. The U-irons, which are braced up by cross-bands, carry as fixtures the tank, the motor, the pumping-plant, and the water and coal-tanks. The front water-tank is adapted as a seat for the fireman. The front axle consists of a quadrangular frame, which carries the components of the steering apparatus and which, in order to be able to steer the vehicle, can be moved horizontally round its centre of rotation. The four wheels of the vehicle have steel gun-carriage limbs and are fitted with india-rubber tyres. Steam is used as motive power for the propulsion of the vehicle and for the working of the pump. Provision is made for a boiler pressure of 3-4 atmospheres which can be kept up permanently at the station by a gas-heating apparatus, and within a few minutes from the start the pressure rises to the maximum of 10 atmospheres. The motor for the propulsion of the vehicle is a double cyclinder engine with Stephenson's regulation. The transmission is effected by means of chains from the flywheel of the engine to the split pulleys over the hind axle. These pulleys carry cog-wheels on their outside, which grip the inside teeth of the hind wheels. The chains of the motor run outside the engine and inside the frame, so that a bearing could be fixed outside on the frame of the vehicle for the shaft of the flywheel. The chain-wheel on the left-hand side of the vehicle is fixed to the shafting by means of a wedge ; the one on the right-hand side is connected with it through a peculiarly constructed sliding catch, so as to allow a different speed of the hind wheels in negotiating curves. The regulation of the engine, as well as the steering of the vehicle with the hand-wheel is carried out by one man, who acts as engineer as soon as the pump is set in motion. Apart from the brake power inherent to the engine, a double hand-brake for hand power is used, which makes an almost instantaneous stoppage of the vehicle possible by the friction effected on the outside of the hind-wheel cog-wheels. The motor admits of a speed of about 28 kilometres on level ground ; and at the various trials, inclines of from 12-14 deg. were taken. Six firemen can be carried together with engineer and stoker.

The engine can be fitted with a spirit-heating appliance, by which the spirit is conducted through spray nozzles from below, to the glowing material on the grate, and



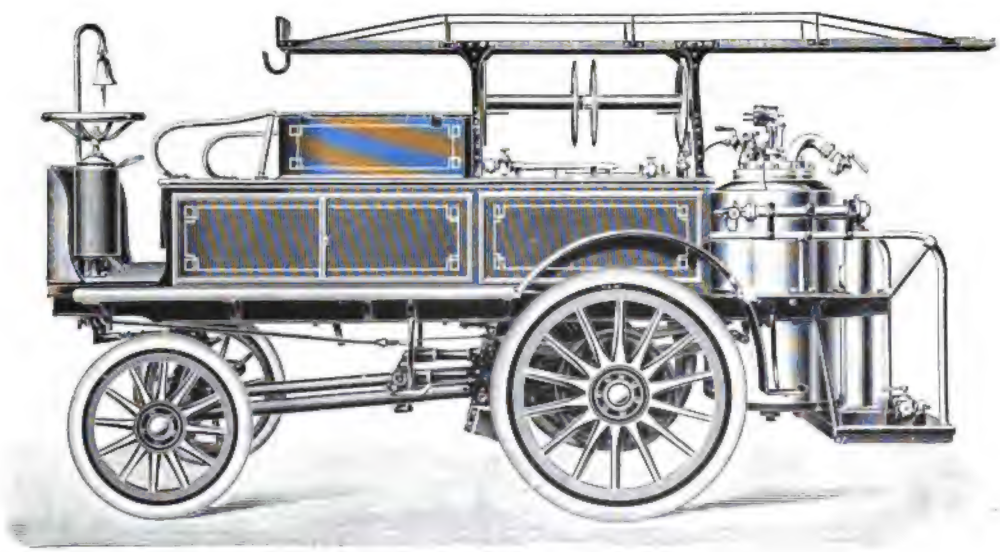
GAS FIRE-ENGINE, WITH REVOLVING FIRE ESCAPE, BY THE NUREMBERG FIRE-EXTINGUISHING APPLIANCES AND ENGINE MANUFACTURING COMPANY, LTD.



AUTOMOBILE FIRE-ENGINE, SHOWN BY THE WAGGON- UND MASCHINENFABRIK A.G. OF BAUTZEN.

which, when the fire-engine has arrived at the place of the outbreak, ignites at once the fuel used—*i.e.*, coal or coke. Moreover, there are fixed two carbonic acid cylinders on the left of the fire-engine outside, which are connected with the boiler in such a way that safe and reliable action is ensured. The fire-engine can thus be started immediately upon the sounding of the alarm signal; while, in the meantime, the pressure necessary for the continuation of the journey is generated in the boiler.

The gas fire-engine of the Waggon- und Maschinenfabrik A.G. of Bautzen is designed for first aid in fire-extinction, and is also used for the transport of firemen and appliances. The water-tank has a capacity of about 400 litres, and is tested to stand a pressure of eight atmospheres. The tank is fitted on the hind part of the vehicle between the two longitudinal beams. The battery of accumulators is to be found under the front and side seats. The space between the battery and water-tank is utilised for the storage of appliances; over this there is a hose-reel fixed for pressure-hose, and above it a ladder board for hook-ladders. The engine can be manned with eight men —three on the front seat, two on each of the two lateral seats, and one on the tailboard. The driver, who has to steer the vehicle and to regulate the speed, sits on the left-hand side of the front seat, whilst the warning bell is sounded by the man who occupies the middle seat, the officer in



GAS FIRE-ENGINE, MADE BY THE WAGGON- UND MASCHINENFABRIK A.G. OF BAUTZEN.

MAGIRUS PATENT TURN-TABLE FIRE ESCAPE, 83 FT., EXTENDED AND TURNED SIDEWAYS.

charge being stationed on the right. The vehicle is fitted with two motors, each of which drives separately a hind-wheel by means of simple cog-wheel transmission. The motors are constructed in such a way that, should one of them fail from any cause, the other one is capable of propelling the vehicle by itself. The lever to start the motors is fixed round the steering-shaft, and four different positions are provided for the forward motion, three electric brake-positions, and two positions for the reversed (backward) motion. The battery consists of 42 cells, which are contained in three wooden boxes. The highest speed of the vehicle is 18 kms. per hour. The consumption of current per km. covered by the vehicle including all losses, amounts to 0·8 kilowatt hours equal to 7·2 ampere hours with 110 volts. The time required for charging is therefore about 6½ minutes per km. The charging current has a strength of 50 amperes. A charging tension of 110 volts is required. The wheels are fitted with india-rubber tyres.

The need for long ladders in fire-brigade work is self-evident. People living on the upper floors of large buildings are relatively more exposed to danger in case of an outbreak of fire than those living on lower floors; they have a much longer way to reach the bottom of the staircase, and are exposed to the smoke rising from below.

In order to interest the different manufacturers in the construction of high escapes, the Society of Arts offered a gold medal for the best long ladder of a height not less than 80 feet, exhibited at the International Fire Exhibition. Only four makers—all Germans—competed for this medal, and all exhibited turn-table escapes.

Thorough tests of the escapes were made on July 10th, the jury consisting of eleven professional men and engineers, with the result that the medal was awarded to Mr. C. D. Magirus, Ulm-on-Danube. These escapes, which are largely used on the Continent, have a four-wheeled carriage bearing a turn-table, upon which the ladder is so fixed that it can be turned horizontally, and inclined at any degree.

There is no doubt but that the turn-table escape system is a very convenient one where long ladders are wanted, but these high escapes are naturally rather heavy. A ladder of this description can only be carried on a four-wheeled carriage drawn by horses, and offering a good foundation for the escape when extended. It could not be carried on two wheels, nor could it be balanced by firemen. The escape is moved, turned, and inclined quite automatically by means of self-controlling mechanisms carried on the carriage.

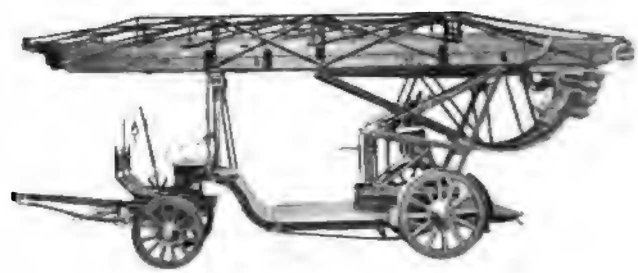
The latter, when in use, remains always in a position parallel with the road, and thus causes a minimum of interference with the ordinary traffic. The extended Magirus Escape can be inclined to a projection of about 40 feet. Different windows can be reached by merely turning the appliance in the required direction. The escape can be carried for short distances with the ladder extended, and not more than four men are necessary to work it at any time.

Of the ladders tested one was made of steel-tubes, another wholly of wood, and two others—one of which was the Magirus Escape—were made of wood with steel

railings. These ladders are so rigid and substantial that they can be mounted freestanding, without the top touching the house, a feature which greatly increases their effectiveness. The escape, placed at a good position in the road, can be used as a water tower, and, in this case, of course, a man standing on the top of the escape carrying the hose is not so much exposed to the smoke and the dangers spreading from a house on fire. Besides this he is in many cases better able to direct the jet into the centre of the conflagration. The damage generally done by water—which is such a serious feature in outbreaks of fire—can also be materially reduced.

The escape can be raised and extended in a very short time ; on the day of the trials, for instance, it took one man only 35 seconds to raise the escape and extend it 82 feet high, whilst two men raised the appliance, extended it 82 feet high, within 24 seconds. This rapid work is effected with the aid of a small double-cylinder engine, driven by carbonic acid, which is carried in large tubes on the escape. There is a patented arrangement which prevents the carbonic acid from becoming frozen. The same engine is used as a kind of brake, in lowering the escape. The Magirus Escape can also be extended by hand.

An ingenious gas fire-engine, with revolving fire-escape, was shown by the Nüremberg Fire-Extinguishing Appliances and Engine Manufacturing Company, Limited. This has been designed more especially to meet the needs of permanent or volunteer fire brigades in small or middle-sized towns, though it is, of course, equally suitable for general use. In this case the ladder attains a maximum of 60 feet, and is easily attended by two men. The hose-reel carried on the engine is equipped with 650 feet of delivery hose, the tank holding about 120 gallons of water for immediate use ; while, to afford the necessary pressure, carbonic acid is stored in four small steel cylinders. The engine, in addition to the firemen, carries a canvas jumping sheet, surgical box, smoke-helmet and apparatus, firemen's axes, torches, lamps, and lanterns. Above the tank is fixed the slide escape, which has a revolving movement, and is made up of three parts. It is claimed that this apparatus can be erected by two men in a minute, extended completely, pivotted 360 degrees, and inclined to the horizontal—the revolving is accomplished by hand.



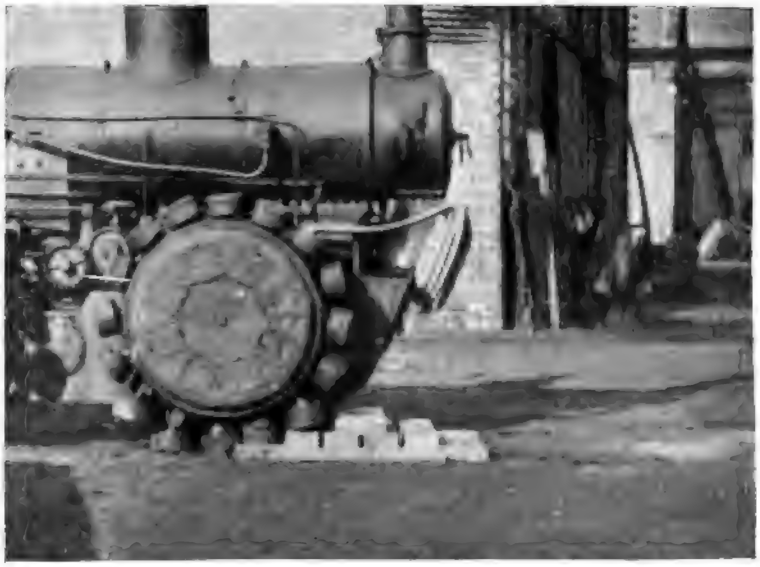
MAGIRUS PATENT TURN-TABLE FIRE ESCAPE, TRAVELLING POSITION.

PROFESSOR HELE-SHAW ON THE PEDRAIL.

PROFESSOR HELE-SHAW, at a recent meeting of the Liverpool Self-Propelled Traffic Association, gave an interesting lecture, entitled "The Pedrail—a Revolution in Mechanical Locomotion." Mr. B. J. Diplock, the inventor of the Pedrail, was present.

In a previous issue of the Magazine we were able to illustrate this invention, and a further account of Professor Hele-Shaw's lecture may therefore be of interest.

Professor Hele-Shaw said a close study of road locomotion and the properties of the wheel for many years had convinced him that the wheel itself had reached its utmost limits of carrying power, both in regard to weight and speed upon the ordinary roads, however well constructed the roads or perfect the wheel. While the wheel would always play a most important part in road and railway locomotion—and he could not picture the possibility of any contrivance taking the place of the wheel and the pneumatic tire under suitable conditions—he was none the less compelled to believe that the mechanical possibilities of engines and motive power, and the construction of the vehicles themselves, had completely outstripped that portion of the moving vehicle which was represented by the wheels. In great inventions the successful solution of a problem had often been found in imitation of the working of nature itself, as in the case of the screw propeller for ocean navigation. Could they say that there was in general use at the beginning of the twentieth century anything that could fairly be considered a means of locomotion on land imitating successfully the marvellous natural process of animal locomotion, but modified to suit the mechanical requirements of the case ? He believed the pedrail to be the solution of that great problem. The pedrail was simply this : Instead of having a permanent rail carried for the whole of its length on sleepers, and wheels running upon this rail, the process was inverted. The feet, or sleepers, were placed upon the ground, but instead of the rails being carried upon the feet, the latter supported wheels which acted as bearers for a short length of rail attached to the moving carriage. The pedrail consisted of two

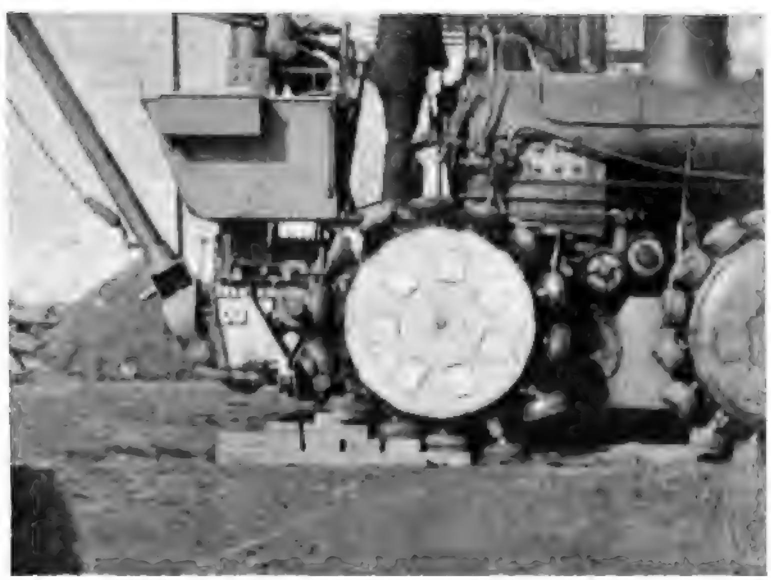


THE PEDRAIL MOUNTING AN OBSTACLE.

main parts. One was a railway fastened to the axle-box without revolution, and the other a kind of circular box carrying sliding spokes, rollers, and feet in such a manner that the rollers and feet were placed in succession on the ground and the rail ran over them. The Professor described the mechanism of the pedrail in detail, illustrating his remarks by exhibiting a small working model, and by cinematograph views of trials conducted by himself at Stoke. The views aptly hit off the Professor's description of the machine as "half traction engine, half elephant," the massive revolving feet in shape and action instantly recalling the movement of a large elephant. He proceeded to express the belief that the pedrail vehicle had passed from the stage of mere theory and initial experiment into the realisation of practice, and that the invention constituted a veritable revolution in road locomotion. The pedrail would climb the steepest hill, walk over large stones and such obstacles as nine balks of timber without damage, or pass over ruts and soft ground with the greatest ease. It could not sink into any hole that would stop the ordinary traction engine. After dilating upon the immense commercial and industrial possibilities opened up by what was the first successful driver on four wheels yet made, and after commenting upon its economy of construction and the adaptability of the pedrail to ordinary traction engines, the Professor concluded by declaring that, in the interests of the progress of road locomotion the world over, they must wish the inventor that success of which there was every indication.

The action of the pedrail on the road was very remarkable. Whereas the ordinary traction engines destroyed roads to such an extent that they had been forbidden in many parts of this country and also in various parts of the world, and heavy motor wagons and traction engines had been severely taxed by local authorities and made to contribute to the repair of the roads, the pedrail positively improved the road over which it walked. This had been proved by actual experiment, and it was more than probable, from the remarks of an eminent municipal engineer, that the pedrail was destined to entirely replace the road roller for repairing roads, as the action of stamping or ramming was much better than rolling for this purpose.

The lecture has been published by Messrs. William Clowes and Sons, Ltd., to whom we are indebted for the accompanying blocks.



STEPPING OFF.

ENGINEERING BUILDINGS A AND B AND PIERCE BUILDING—MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

FAMOUS TECHNICAL INSTITUTIONS.

The first of a series of illustrated articles, which will give brief descriptions of the most important technical institutions at home and abroad.—Ed.

I.—Massachusetts Institute of Technology.

THE first technical institution dealt with by Professor W. E. Dalby, M.I.Mech.E., in his paper on the education of engineers in America, Germany and Switzerland, was the Massachusetts Institute of Technology of Boston, and in briefly reviewing the work of some of the most famous technical institutions of the world, we cannot do better than follow his example and start with the mechanical engineering department of this institution.

The course in mechanical engineering at the Massachusetts Institute is designed, according to its sponsors, to give to the student a thorough training in scientific principles in such a manner that he may be able, instead of relying upon rule-of-thumb methods, to apply these principles to the solution of practical problems. It aims not only to acquaint him with current engineering practice, but also so to develop the powers of his mind that he may be able, as occasions arise, to make improvements, and thus keep abreast with the progress of the times. As large a practical element as time will allow is introduced into the recitation room, the drawing room, and the laboratory, the practical work being arranged to follow, and not to precede, the theoretical instruction bearing upon it.

The students are required to perform tests in the engineering laboratories under the conditions of practice: and the apparatus and machinery employed are of practical proportions. They are not only drilled in accurate experimentation, but also carry on a considerable amount of valuable investigation.

A word of advice is offered to mechanical engineering students at the outset as to the vital necessity of a thorough grounding in mathematics, physics, and drawing (including descriptive geometry).

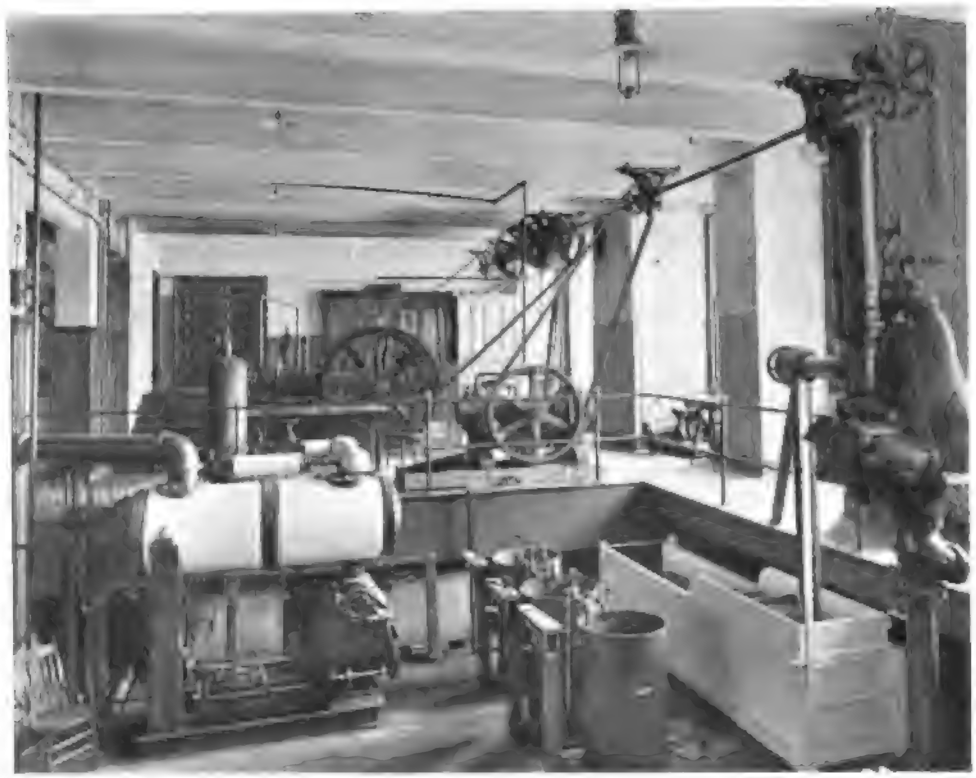
OUTLINE OF THE COURSE.

The course in mechanical engineering may be classified as follows:—

(a) Mathematics, physics (including technical electricity), and applied mechanics, given outside the department, the

IN THE MECHANICAL ENGINEERING LABORATORY—THE EMERY TESTING MACHINE IS OF 300,000 LB. CAPACITY.

THE MACHINE TOOL LABORATORY.



ANOTHER VIEW OF THE MECHANICAL ENGINEERING LABORATORY.

last including the study of and practice in testing the strength of materials.

(*b*) Class-room work of the department proper.

(*c*) Drawing.

(*d*) Engineering laboratory work.

(*e*) Mechanic arts.

(*f*) Visits to engineering works and manufacturing establishments.

The most fundamental subjects given outside the department are mathematics, physics, and applied mechanics.

As Professor Dalby pointed out, the course of instruction in America is very exactly laid down, the students being compelled to follow it step by step. "Slight variations are permitted in the form of options, to use their term, in the later periods of the course. But whatever option is taken, the student must go through with it. He gets his degree from the gradually accumulating results of terminal and sessional examinations, ending finally with a thesis. He is, in fact, put through a thoroughly well-organised species of educational drill, and must work or fall out."

SUMMARY OF THE COURSE.

The work of the first year is, of course, mainly introductory. The Second year's course comprises :—

(*a*) ***Mechanism.***—The course includes a systematic study not only of the motions and forms of the various mechanisms occurring in machines, and the manner of supporting and guiding the parts, independently of their strength, but also of the design of gear-teeth, and the study of the mechanisms found in modern American machine-tools, and in cotton machinery.

(*b*) *Drawing.*—The students make working drawings of parts of machinery from measurements, and the drawings illustrating the class-room work in connection with the course in mechanism.

(*c*) *Mechanic Arts.*—Includes carpentry, pattern-making, and foundry work.

Third year :—

(*a*) *Applied Mechanics.*—This course extends through the third and fourth years. In the third year the subjects taught are statics, dynamics, strength of materials and graphic statics, in the order named. The calculus is freely employed throughout.

(*b*) *Valve-gears.*—This course includes the study of the different types of valve-gears, the design of simple and double valves by the use of the Zeuner diagram, the study

of the Stephenson link, and the working out of the same by the use of the skeleton model in the drawing room.

(*c*) *Steam Engineering.*—The course includes a thorough mathematical treatment of thermodynamics; a discussion of the properties of gases and vapours, especially steam; of the flow of gases and vapours; of the injector; of hot-air engines and gas-engines; of steam-engines; of air-compressors and compressed air machinery; and of refrigerating machines; besides which about one-half term is devoted to the study of steam-boilers, their details and accessories.

(*d*) *Drawing.*—The course in drawing aims to teach the proper way of making the necessary dimensioned drawings, tracings, and blue-prints for use in practice, good shop systems being adopted.

(*e*) *Dynamo-electric Machinery.*—This course includes a discussion in the lecture-room of the principal applications of electricity to the industrial arts, and in the laboratory of the most important general methods of commercial electrical testing of dynamo machinery, and the use of the instruments ordinarily employed in such testing.

(*f*) *Engineering Laboratory Work.*—This work is given during the second term, and is devoted to drill in steam-engine tests, for which the 9-in., 16-in., and 24-in. by 30-in. triple-expansion engine, and also the 11-in. and 19-in. by 15-in. tandem compound engine, are used. In these engine-tests the water consumption is determined by condensing and weighing the steam after it has passed through the engine.

(*g*) *Mechanic Arts.*—The instruction in mechanic arts of the third year includes forging and a portion of the chipping and filing.

Fourth year:—

In the fourth year the following studies are pursued by all students: Applied mechanics, machine design, steam engineering, engineering laboratory work, hydraulics and hydraulic motors, industrial management, dynamics of machines, and mechanic arts. The industrial management course involves a study of the organisation and relations of the various departments of an industrial establishment, both in the office and in the workshop, the conduct of accounts, the methods of compensating labour and of superintendence, and a careful study of the effect on cost of production of different systems of distributing indirect expenses.

Fourth year students are offered four options, of which one is required, *i.e.*, marine engineering, locomotive construction, mill engineering, and heating and ventilating.

THE FORGING LABORATORY.

THE ENGINEERING LABORATORIES.

The engineering laboratories fro testing, hydraulics, and steam at Trinity Place, are very completely equipped, and occupy a floor space of about 21,000 square feet. The mechanical laboratories at Garrison Street afford the means of practical instruction in the nature of materials of construction, and in the typical operations involved in the arts. It may be mentioned that the carpentry, wood turning, and pattern-making laboratories employ some forty carpenters' benches, two circular-saw benches, a swing-saw, two jig-saws, a buzz-planer, thirty-six wood-lathes, a large pattern-makers' lathe, and thirty-six pattern-makers' benches. The founding laboratory has a cupola furnace for melting iron, two brass furnaces, a core oven, and thirty-two moulder's benches. In the forging laboratory are a power hammer, thirty-two forges, seven blacksmith's vices, a blacksmith's hand-drill, and power-shear. The machine-tool laboratory contains twenty-three engine-lathes and seventeen hand-lathes, a twenty-four-inch turret lathe, two machine drills, three planers, a shaping machine, two universal milling machines furnished with spiral and gear-cutting attachments, a universal grinding machine, a cutter and reamer grinder, thirty-two vice benches arranged for instruction in vice work, a twenty-four-inch standard measuring machine, special apparatus for hardening and tempering, and a fully equipped tool room.

The accompanying illustrations, for which we are indebted to Mr. Harry W. Tyler, the secretary of the college, afford an excellent idea of the extent and completeness of these famous laboratories.

ARCH-TESTING MACHINE IN THE MECHANICAL ENGINEERING DEPARTMENT.

NAVAL ARCHITECTURE.

The course in naval architecture provided by the Institute, though relatively new, is already well grounded and established. Like all the courses at the Institute it gives in addition to a professional and technical training, a good scientific and liberal education.

The advantageous location of the Institute at an important sea-port, and near a navy yard, enables students to see ship and engine construction, and to visit ships of all types. This fact has made it possible to arrange for progressive speed-trials, tests of engine and boilers, and tests for locating the centre of gravity of a ship.

The department has a collection of complete sets of drawings of ships and their machinery, both merchant ships and warships, systematically arranged and catalogued, which, together with the proper data concerning construction, power and speed, makes it possible to proceed with the design and arrangements of ships as in actual practice.

There is a supply of planimeters and integrators which the students use freely, and a calculating machine with which they may become familiar. An optional course of lectures gives instruction in the use of slide-rules, calculating machines, etc.

HANDLING HEAVY FREIGHT IN RAILWAY YARDS.

OUR illustration shows the latest type of an economical apparatus for handling heavy and bulky freight in railway yards. It includes a 40-ton Niles Overhead Electric Travelling Crane, 48 ft. span, and a substantial structural steel runway 40 ft. long. The crane spans three tracks, and leaves a wide passage way, which gives ample approach for teams and trucks on one side of the cars covered by this apparatus.

In addition to the main hook, a quick-running auxiliary hook of 5 tons capacity is provided for the rapid and efficient handling of light loads, which performs by far the greater part of the service of the crane.

The bridge consists of two heavy curved girders, of box section. It is driven longitudinally on the runway by motor located on the front girder, which is geared to the truck wheels, on either side, the motion being controlled by a foot brake in the operator's cage, which acts directly upon the armature shaft of the motor.

A foot bridge is provided the entire length of the span, with customary guard rail. The bridge trucks are of built-up type, securely fastened with the utmost rigidity to the girders, provided with heavy cast steel, double flanged truck wheels with treads accurately finished to uniform diameter.

The trolley is the standard type used on overhead cranes, consisting of heavy side frames securely bolted together, and kept in perfect alignment by a separator. All the gearing is cut from the solid, and runs encased in oil, which gives the entire mechanism an unusually high mechanical efficiency.

Both hoists are provided with mechanical and electric brakes, also circuit breakers and limit switches to prevent overwinding and consequent damage to the crane or its load. The trolley, operator's cage, and bridge drive motor are of the inclosed type, affording suitable protection from the weather.

This crane is notable because of the extra height of lift, which enables the loaded hook to clear the top of box cars or other obstructions while performing the functions of its regular service of loading and unloading.

The complete apparatus was manufactured, installed, and erected by the Crane department of the Niles-Bement-Pond Company, Meadow and Mifflin Streets, Philadelphia, Pennsylvania. It is installed in the yard of the Buffalo and Alleghany Valley Division of the Pennsylvania Railroad Company.

40-TON NILES OVERHEAD ELECTRIC TRAVELLING CRANE.
Used for handling heavy railway freight.

NEW MACHINE TOOLS.

NEW GATE SAWING MACHINE.

Messrs. Edward G. Herbert, Ltd., have recently added to their line of metal sawing machines a new machine for sawing the "gits" off brass and other castings. The general idea of the machine is sufficiently explained by the illustration. The "git" to be cut is rested in the angle of the bar support, and the operator, who has both hands free to hold the castings, presses the foot lever by means of which the machine is started and the saw is fed through the "git." The feed of the saw is a gravity feed, which can be checked but not accelerated by the operator, who cannot jam the saw in the work. The saws are hard, of special make, and will cut the harder alloys of copper and also Delta metal and aluminium. With this machine "gits" can be rapidly cut off flush with the casting without fear of damaging the latter. "Gits" up to 1½ in. diameter can be dealt with at one cut, and larger sizes can be severed by two or more cuts. An important feature is that the saw stops running as soon as the treadle is released.

GATE SAWING MACHINE BY MESSRS. EDWARD G. HERBERT, LTD.

A DOUBLE HORIZONTAL PIPE FLANGE DRILLING MACHINE.

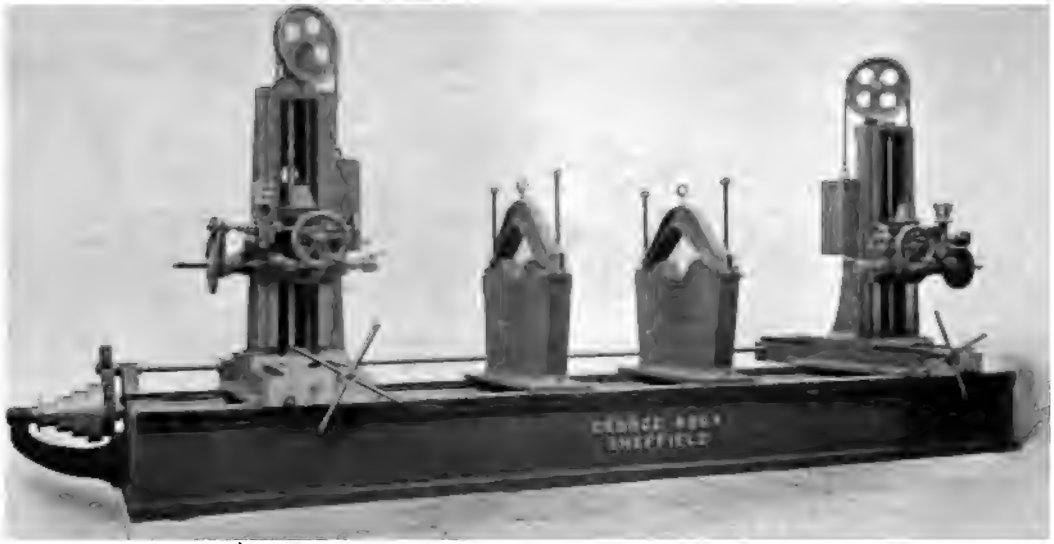
The wonderful economy of modern machine tools is well illustrated by Mr. George Addy's large double horizontal pipe flange drilling machine. This tool will take pipes up to 12 ft. in length, and 48 in. in diameter. Instead of each hole being dealt with singly, the pipe is simply dropped into the two cradles shown, fastened down, and kept in the one position until all the holes have been drilled. As both flanges are dealt with simultaneously, much time is saved, the economy resulting from the use of this tool, when compared with the old system, being estimated at 75 per cent. The bed, which is of box section, and of large dimensions, carries two uprights, each having a drill head provided with a forged steel spindle and self-acting variable feed motion. The drill heads can be moved into any position necessary for boring the bolt holes in the flanges of long or short pipes. The motions of the drill heads are entirely independent of each other, and can be run separately or together. Two large adjustable V blocks with portable top cramps are provided for holding the largest pipes, and loose V pieces are fitted therein to accommodate smaller pipes.

If desired, one or two loose adjustable tables can be supplied for holding bends and elbows, each having V blocks. These tables are bolted to the side of the bed in suitable T slots, and are pinched along the bed by means of a rack and pinch bar. The bevel gearing is amply protected by loose covers, and it will be noted that all movements are within easy access of the operator.

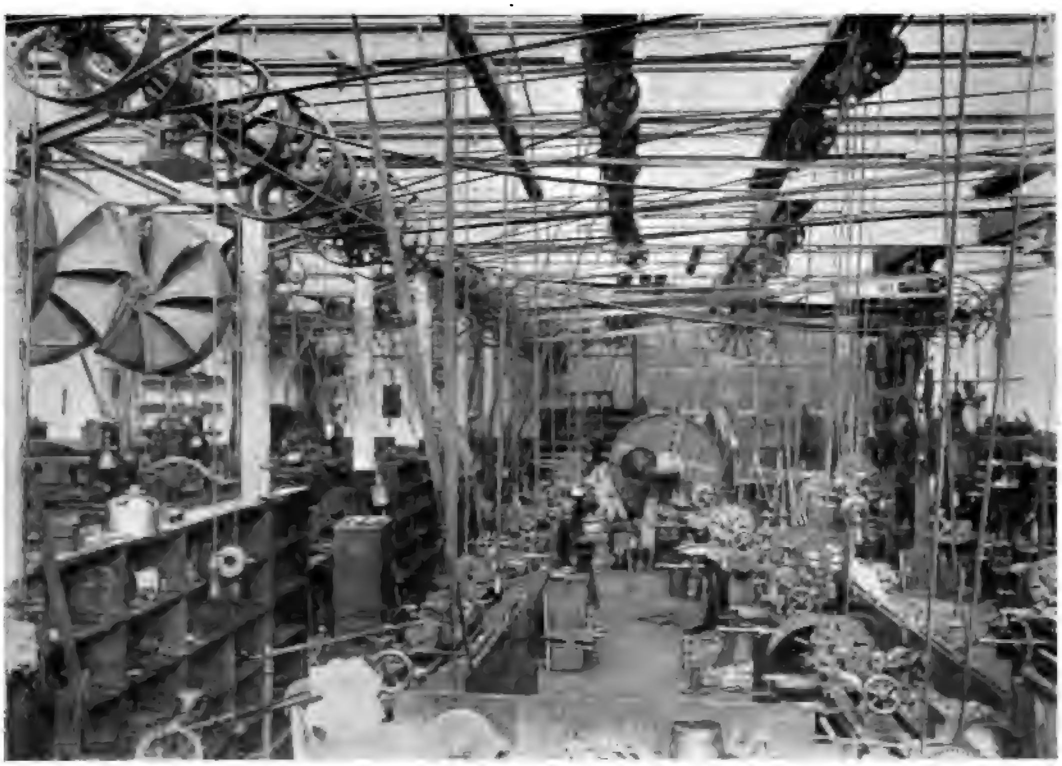
The machine is also useful for drilling the ordinary work in an engineer's workshop.

THE LIGHTING OF WORKSHOPS.

The accompanying illustration, showing the tool-room at the works of the James Keith and Blackman Company, Ltd., is presented as a good example of a well-lighted shop. There are no windows, but the roof is of the saw-tooth pattern, with 10-ft. spans, having a steep slope of glass in the north side of each ridge, and a longer slope of slate on the south side of each. The view is, of course, taken looking south.



DOUBLE HORIZONTAL PIPE FLANGE DRILLING MACHINE BY GEO. ADDY



TOOLROOM AT THE WORKS OF THE JAMES KEITH AND BLACKMAN COMPANY, LTD.

Tire Testing.

[illegible] a lever carry [illegible] the apparatus [illegible] The wheel shown [illegible] (called No. 2) is arrang[illegible] a horizontal line at [illegible] which so [illegible] plane [illegible] wheel No. 1 [illegible] wheel [illegible] support is attach[illegible]

to a heavy pendulum weighing upwards of 2 tons, which may be seen in the pit below the apparatus.

If this pendulum is caused to rock to and fro while the wheels are revolving, the strains which are set up in the fabric of the tyres are similar in character to those which take place in the fabric of motor-car tyres when driven rapidly round curves varying in direction.

Two 50 h.p. electric motors are employed, both of which may be used either as a motor or as a dynamo. Assuming that No. 1 wheel is driven by No. 1 motor, and that No. 2 motor is disconnected, the apparatus is then "running light," and if the pendulum is stationary in a vertical position, the conditions are then similar to those of tyres on a loaded car running on a level road, No. 1 being the driving and No. 2 the front wheel.

If No. 2 motor is connected as a dynamo, then the conditions at No. 1 wheel are similar to a loaded car going up a very steep hill, and the conditions at No. 2 wheel are like those of a loaded car going down a very steep hill with the brakes fully on.

By means of special apparatus on the electrical switchboard, it can be seen at a glance how much electrical horse-power is supplied to motor No. 1, and also how much is given out by motor No. 2 being run as a dynamo; and by making allowance for friction of the apparatus, an approximate estimate may be obtained of the power absorbed by the tyres, which is very useful in comparing different makes. A series of jets of air directed on the surface of the tyres makes the condition similar to those of a motor car travelling in the open air.

An Automobile Machine Shop.

A battery wagon just completed by the U.S. Long Distance Automobile Company, of Jersey City, N.J., and delivered to the War Department at Washington. is to all intents and purposes a travelling machine shop of automobile type. The machine as illustrated by *The Iron Trade Review*, weighs about five tons and is propelled by a 4-cylinder 24-h.p. gasolene engine. The front wheels are 48 in. in diameter and the rear wheels 56 in. in diameter, fitted with Firestone solid rubber tyres. The vehicle has four speed changes in the forward direction and there is a reversing gear. There is ample supply of shelves, drawers and compartments for the storage of tools and general appliances, and on top of the machine are placed the extra artillery wheels and poles for the hoist, etc. The machine shop has a lathe, grindstone, emery wheel, forge, anvil, and a dynamo for lighting purposes. The wagon is capable of travelling at a maximum speed of about 10 miles per hour with full equipment of tools, etc., and the quota of men.

The Motor Reliability Trials.

The 1,000 miles Trials of 1903 were carried out under the guidance of the experience gained from the 500 miles Trials held in Glasgow in 1901, and the 650 miles Trials in 1902; but owing to the greatly increased trustworthiness of cars, it was decided, moreover, to make the conditions so stringent that only those cars of superlative merit would get through with maximum marks.

Full details of the marks gained will be found in the "Automobile Club Journal," in which it is remarked that a vast amount of very valuable knowledge has been gained during the Trials; for instance, marks were allotted in proportion to freedom from dust raising in order to encourage the manufacturers to pay attention to this point, and to afford an opportunity to the Judges for obtaining some accurate data as to the conditions governing the raising of dust.

A novel feature was the taking of the fuel consumption throughout the *whole* of the trials. In view of the certain early adoption of motor vehicles for the carriage of goods, in which cost of fuel will be an important feature, there is no doubt that it is of extreme value to encourage makers to pay much more attention than they have hitherto done in the past to this point. The marks were allotted on a basis of actual pence per ton mile.

Association for Motor Van and Wagon Users.

It has been decided to form an association for motor van and wagon users, as a section of the Motor Union. Its objects are as follows:—

(1) To represent the views of motor van and wagon users before the Local Government Boards; (2) To resist undue restrictions being placed upon the use of motor vans and wagons by local authorities; (3) to consider any claim for financial and legal assistance in respect of actions at law, either civil or criminal, in connection with the use of motor vans and wagons; (4) to inquire into the question of tare weight of motor vehicles and other questions connected with the users of mechanically-propelled vehicles for the carriage of goods, and to collect information respecting the use of motor vehicles likely to be of service to the members: (5) to originate and promote improvement in the law from time to time directly or indirectly affecting self-propelled vehicular and locomotive road traffic, and to support or oppose alterations in such law; (6) to popularise and assist the development of self-propelled vehicular and locomotive road traffic; (7) to give information and advice, and generally to protect and extend the rights and privileges of users of motor vans and wagons.

Side Slip Competition.

The Automobile Club announces a side-slip competition, which will be held next year. Particulars of devices to be submitted should be forwarded, with drawings, not later than February 29th, to the headquarters of the club.

In interpreting the results of tests, the design of car on which the device is tested as affecting side-slip will be considered. Consideration will also be given to the effect of the device upon the speed or resiliency of the tyres or power needed to drive it; to the effect upon the road; to the effect upon the life of the tyre; to the liability to dangerous derangement or fracture; and to the price. The cars will be submitted to a Preliminary Test, which will consist of a run on a greasy surface, made up of a twisting course, to be covered within a certain time. All cars entering for this trial must weigh at least fifteen hundredweight without passengers. The Preliminary Side-slip Trial will take place on a private road or track consisting of concrete, cement, wood, or some similar surface, covered with some slippery clayey material. Competitors whose devices may be considered worthy will then participate in the endurance test which will consist of a run of not less than five hundred miles.

COAL HOISTING TOWERS BUILT BY THE C. W. HUNT COMPANY FOR USE AT THE LINCOLN WHARF POWER STATION OF THE BOSTON ELEVATED RAILWAY COMPANY.

and discharging it therein, is frequently performed in twenty-two seconds.

The installation, shown in the illustration, follows in general design, but in heavier proportion, the standard Hunt Steeple Tower Rig, the moving gear and coal cracker being electrically driven and the hoisting engine direct connected. The towers have to traverse overhead the whole length of the coal storage pocket and to move 30 ft. at a time without changing steam connection. In this way a single tower can operate on each hatch of a vessel in turn, or several towers can work simultaneously.

The boom, made to fold up, for the free manipulation of vessels with their rigging, has an overhang of 40 ft., and enables the tower to operate on coal steamers of the widest beam and largest dimensions.

NEW PLANT FOR DURBAN.

According to the *Colliery Guardian* there is a prospect of increased exports of Natal coal in the near future. The Government have recently restored the railway rebate on exported coal, and elaborate handling appliances are about to be erected at Durban and Delagoa Bay. The plant devised for Durban consists of two revolving tipplers, capable of taking trucks of 40 tons or less capacity. In dumping, the coal is discharged into a large hopper underneath the wharf, and from it conveyed by a broad belt up an incline to storage bins specia constructed of steel, and with a total capacity of 6,000 tons, the space being divided into compartments, each company so desiring to have the means of keeping its own coal apart from others. In drawing upon these stored reserves a second belt conveyor is employed which delivers the coal to the cross-conveyor by which it is carried to the ship, if necessary over a vessel lying "second off" the quay, and deposited through a patent chute or telescope, in bunker-hatch or hold. The capacity of the device is about 500 tons per hour, and by employing each of the three distributors provided for, 1,500 tons of coal can be handled in a single hour. An automatic machine for weighing the coal as it passes over the belt is part of the general arrangement. Coal can be also loaded direct from the trucks into the ship without passing through the storage compartments, and in such cases truck weights are taken. The plant has been designed to be operated by electricity, but steam may be used if desired. The amount of labour required to keep it running, if electrically equipped, has been estimated at two good mechanics and five labourers. Similar apparatus has been designed for Delagoa Bay, the cost involved in each case being estimated at £60,000.

ANOTHER VIEW OF THE SHOVEL DESCENDING INTO THE HATCH OF A VESSEL.

THE "BARTON" AIRSHIP.

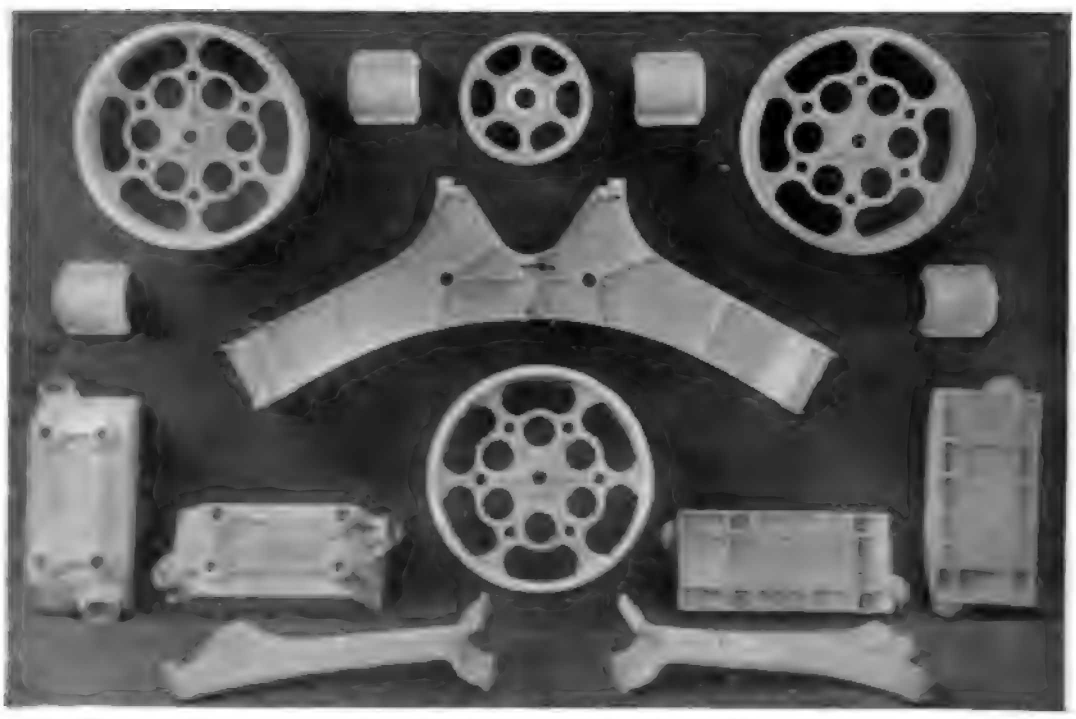
DESCRIBED BY ITS INVENTOR.

THE chief point in the "Barton" Airship is the introduction of movable aeroplanes between the cylindrical balloon and elongated car. The balloon is 180 ft. long and 42 ft. diameter, with a capacity of 230,000 cubic feet. The framework of the car is triangular in section, the apex pointing downwards to the keel. The base of the triangle is 10 ft. 6 in., the two sides being 24 ft. in length. The main structure is made of bamboo of an average diameter of 4 in. The deck consists of nine platforms joined by light bridges. The three main platforms, which are situated in the centre, bow and stern, are for the three 50-h.p. Buchet motors. These motors rest on two aluminium bridges. There is a third bridge of somewhat different form, placed parallel to the other bridge behind the motor. These bridges spring from the large bamboos which form the ribs of the car, and are joined longitudinally to one another by steel shafts.

The method of drive is as follows: clutch, pinion, two gear-wheels, two driving pulleys, Balata belt, two driving pulleys on propeller shaft. The pinion and gear-wheels are compressed Whitworth steel, and the pulleys of aluminium designed by the "Unbreakable Pulley Company," and cast by Messrs. Mills and Co. They are fitted with phosphor bronze bushes. The propellers, designed by Mr. G. Walker, and manufactured by Messrs. G. Wailes and Co., of tubular steel and gun-metal unions, are six in number, and are placed laterally along the ship, one on each side of each motor.

The propeller shafts are carried in bearings in aluminium slipper plummer blocks. These blocks in their turn are carried on four steel tubes, the ends of which are received in sockets in aluminium caps. These caps, or boom-ends, also have sockets at the top and bottom for stout bamboos which are connected with the upper aeroplane frame, and the keel of the car, respectively, thus forming a pentagonal section round about the triangular section of the car.

The three engineers are in telegraphic communication with the helmsman by means of Bowden wires, and the same are used for throttling the engine and working the clutches. The aeroplanes are thirty in number, arranged in three series, one in front of each motor.



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The framework in which these aeroplanes are held is of tubular steel, and gun-metal unions, manufactured by the Farringdon Works and Pontifex, Ltd. Each series consists of ten aeroplanes, five on each side of the deck, and actuated by the engineers. Each aeroplane is 15 ft. wide, and 3 ft. long, the front edge being fixed, but the back is capable of being raised and lowered through an arc of 60 deg.

The raising and lowering of the airship is obtained by means of these movable aeroplanes, which obviates the necessity of letting out gas, or throwing out ballast, the only method hitherto adopted. Longitudinal stability is obtained by means of two water-tanks connected by pipes passing through a motor-driven pump. The tanks are situated at the bow and stern of the ship, and are capable of holding fifty gallons of water each. The airship is steered by means of a rudder 240 square feet in area. This rudder is on the partially balanced principle, the pivot on which it works being two-fifths from the front edge.

The motors are cooled by means of Clarkson's radiators, which are attached to the tubular steel booms behind each of the propellers. The estimate of the total weight of the airship, crew, water, petrol, etc., is 15,700 lb.

The various castings made by Messrs. W. Mills and Co., for the airship, were as follows:—

No. of castings made.	Description.	Weight of each casting.	Dimensions.
6	Large pulleys ...	42 lb.	2 ft. 3 in. diameter by 7½ in. broad by 1¾ in. bore.
6	Small pulleys ...	22 "	1 ft. 3 in. diameter by 7½ in. broad by 2¾ in. bore.
12	Boom ends ...	43 "	2 ft. 6 in. by 1 ft. 1 in. by 10 in. over all.
6	Engine bridges (2 castings to each bridge)...	45 "	
12	Keeps for ditto...	4½ "	9 in. by 3 in.
6	Gear bridges ...	48¾ "	Ditto
6	Keeps for ditto...	4½ "	Ditto

COMING EVENTS

January, 1904.

2nd.—Birmingham Association of Mechanical Engineers: President's Inaugural Address.

4th.—Institution of Mechanical Engineers: Graduates' Monthly Meeting.

5th.—Junior Engineering Society: General Meeting at Swindon.

7th.—Civil and Mechanical Engineers' Society: Meeting at Caxton Hall at 8 p.m.

11th.—Edinburgh University Chemical Society: General Meeting.

12th.—University of Liverpool Engineering Society: General Meeting.—Junior Engineering Society: Meeting at Swindon.—Institution of Civil Engineers: Ordinary Meeting.

13th.—Liverpool Engineering Society. General Meeting at the Royal Institution.

14th.—Birmingham University Engineering Society: Ordinary Meeting.—Institution of Electrical Engineers: General Meeting at the Institution of Civil Engineers.

15th.—City of London College Science Society: General Meeting.—Institution of Mechanical Engineers: Ordinary Meeting.

16th.—North-East Coast Institution of Engineers and Shipbuilders: Graduates' Meeting.—Manchester Association of Engineers: President's Inaugural Address.—Staffordshire Iron and Steel Institute General Meeting.

19th.—Institution of Civil Engineers: General Meeting at 8 p.m.

20th.—Liverpool Engineering Society: General Meeting at the Royal Institution.

21st.—Birmingham University Engineering Society: Ordinary Meeting.—Institution of Mining and Metallurgy: General Meeting.

22nd.—North-East Coast Institution of Engineers and Shipbuilders: General Meeting.—Junior Institution of Engineers: Presidential Address by J. Fletcher Moulton, Esq., K.C., M.P., F.R.S.

25th.—Society of Arts: Cantor Lecture.—Edinburgh University Chemical Society: General Meeting.

26th.—University of Liverpool Engineering Society: General Meeting.—Junior Engineering Society: Meeting at Swindon.

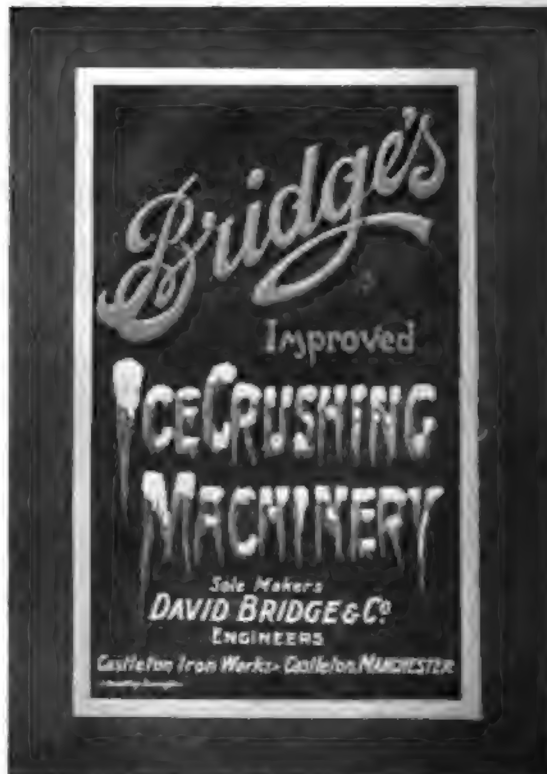
27th.—Liverpool Engineering Society: General Meeting

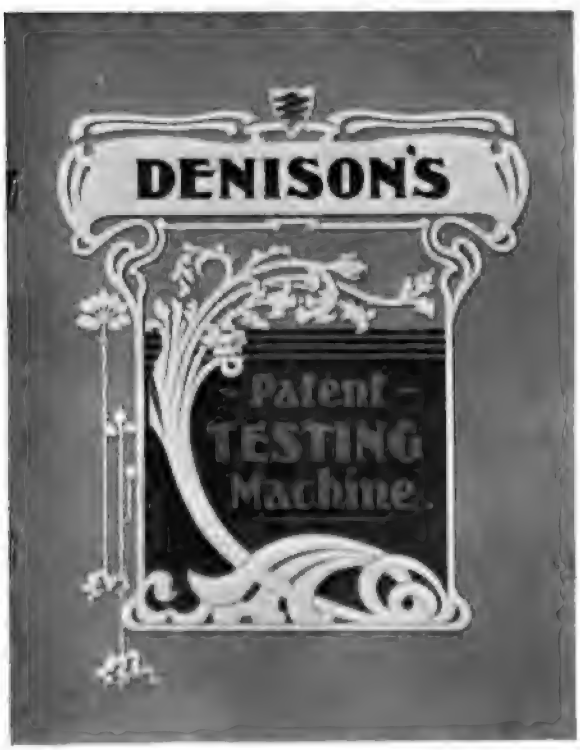
28th.—Leeds Association of Engineers: General Meeting.

30th.—Manchester Association of Engineers: General Meeting.—Midland Counties Institution of Engineers: Joint Meeting at Sheffield.—Staffordshire Iron and Steel Institute; General Meeting.

CATALOGUE COVER DESIGN.

In both these designs silver has been effectively introduced—in the case of Messrs. David Bridge and Co., to convey the suggestion of frost covering the words "Ice Crushing Machinery." For this cover subdued colours have been chosen: dark green forms the background, while the centre panel, framed in silver, is of a chocolate tint. For the title a lighter shade of green has been employed, and the name "David Bridge and Co.," etc., is executed in silver, the whole producing an appropriate and harmonious effect. The interior of the catalogue is attractively arranged, and it has been put together with a due regard to the value of time, the various tables, giving sizes and prices, being clearly set forth, and the whole catalogue provided with an index.





In the pamphlet dealing with Messrs. Samuel Denison and Son's Patent Testing Machine, the work of the artist is thrown into relief in silver. The name is displayed in black, the design being a thoroughly artistic conception, and reflecting much credit on the designer—Mr. Sanderson, of Leeds. The groundwork is of a brownish tint, and the hinges, represented on the outer edge, are shown in black. The small silver shield at the top bears the words "Engineering Employers' Federation, 1896." The interior of the pamphlet consists of art sheets stapled together, and there are a number of excellent illustrations.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining and Allied Industries.

DAVIDGE PAGE, Editor,

Clun House, Surrey Street, Strand, London, W.C.

Telephone No: 3349 GERRARD.

Telegraphic and Cable Address: "SINEWY, LONDON."

Editorial.—*All communications intended for publication should be written on one side of the paper only, and addressed to "The Editor."*

Any contributions offered, as likely to interest either home or foreign readers, dealing with the industries covered by the Magazine, should be accompanied by stamped and addressed envelope for the return of the MSS. if rejected. When payment is desired this fact should be stated, and the full name and address of the writer should appear on the MSS.

Correspondence *is invited from any person upon subjects of interest to the engineering community. In all cases this must be accompanied by full name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

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Copy for Advertisements

should be forwarded on or before the 3rd of each month preceding date of publication.

OUR MONTHLY SUMMARY.

LONDON, December 22nd, 1903.

Our New Battleships.

The purchase by the British Government of the two Chilian battleships, the *Libertad* and *Constitucion*, built respectively by Messrs. Vickers, Sons and Maxim and Sir W. G. Armstrong, Whitworth and Co., Ltd., appears to have given general satisfaction. For strategic reasons it would have been scarcely politic to have allowed these two powerful fighting ships to have been absorbed by a foreign navy, and they have been secured, moreover, at £1,875,000 instead of the £2,200,000 previously asked. It is generally known that a man-of-war is a compromise, and that there is a considerable divergence of opinion even among experts as to what constitutes an ideal battleship. These vessels having been designed outside the sphere of our control naturally embrace features which are not altogether in accordance with the views on construction which prevail at the Admiralty, and their acquisition will consequently necessitate the introduction of new ideas, the effects of which will be most carefully watched. They are powerfully armed—the *Libertad* has a complement of forty-six guns—and are well armoured, though their armour is not carried into the bows in accordance with the modern practice of the Admiralty. On the other hand the normal coal capacity is more circumscribed than is usual in our first-class battleships. The *Libertad* has exceptional accommodation for the comfort of the men. During her trials she showed her ability to steam at 17½ knots an hour with a coal consumption of 1·71 lb. per i.h.p., while at the full-power trials of six hours' duration the vessel ran six times over the measured mile on the Clyde, and developed a mean speed of 20·17 knots, with the engines running at 158 revolutions, the coal consumption being 1·73 lb. per i.h.p. per hour. Two effective warships are thus added to the navy at a reduced cost.

The Turbine in the United States.

The rapid development of turbine machinery in this country is likely to be well seconded in America. Elaborate tests of the leading turbine engines have been made by a specially appointed Board for the Bureau of Steam Engineering of the American Navy, and the conclusions of the Board have been embodied in two reports. It is strongly recommended that turbine engines be installed in one or two types of war vessels, for the purpose of conclusively determining their efficiency for general use in torpedo boats, destroyers, etc.

The first large set of steam turbines installed for screw propulsion in the United States being those of the steamer *Revolution*, it seemed appropriate to the Board to deal with the general performance of these turbines. They are of the Curtis two-stage, compound, marine type, reversible and condensing. Aside from the ordinary advantages claimed for the steam turbine, the most noticeable feature observed was the almost entire absence of vibration or disturbing noises usually attending the running of fast-moving reciprocating engines, and the slight care and attention needed while in operation. The turbine engines were

easily started, stopped and reversed, the time required for each operation being only that necessary for the opening and closing of a set of valves connecting the turbine casings with the main steam pipes. Five seconds was the maximum time consumed for the operation of reversing the motors from full speed ahead to full speed back, with two men handling the gear, one to each turbine. This may, however, be done by one man at a slightly increased expenditure of time.

Running full speed ahead with both screws, and then suddenly reversing the engines, the ship was brought to a standstill in about thirty-two seconds; the same conditions with one screw required about thirty-eight seconds. Similar operations were repeated with the vessel running at lower speeds, and about the same amount of time for reversing was required.

The trial of the Parsons engine was made with one 1,000-kilowatt steam turbine, built for the Cleveland Elyria and Western Railroad. It was of the two-stage type, direct connected to the revolving field of an alternating current generator, 400 volts, two-pole, three-phase, 3,000 alternations.

It was noted that the turbine ran without noise, the humming discernible being due to the generator. Its revolving parts, being accurately balanced, ran perfectly smooth, without even the slightest vibrations.

It is remarked that, compared with the reciprocating engine, there are fewer parts in the turbine that need watching, and a smaller engine-room force will, in all likelihood, therefore suffice.

The space occupied by a battleship engine of the usual stroke and piston speed is approximately 0·75 cubic foot per i.h.p. The space required for the turbine (bringing the cylinders close together and eliminating the generator) is about 0·68 cubic foot per i.h.p., the above being figured on a basis of efficiency of 0·85 in the reciprocating engine. The weights of the turbine may be cut down to some extent by substituting steel castings where now cast-iron is used—for instance, in bed plate and casing.

The Province of Wireless Telegraphy.

The extinction of the submarine cable services, which at one time might have been supposed to be imminent, seems hardly likely to be witnessed in our generation, but there is still a good deal of difference of opinion as to the province of wireless telegraphy. Sir J. Wolfe Barry, at the recent annual dinner of the Institution of Electrical Engineers, replying, on behalf of telegraph enterprises, said there were now no less than 225,000 miles of cable throughout the world, and considerably more than half were British. The capital held in this country in cable enterprise was £30,000,000, and the international messages with Great Britain numbered more than 100,000,000 words per annum, of which one-fifth were Government and Press messages. As to the possibilities of wireless telegraphy, he yielded to no one in his interest in that fascinating subject, but he would point out that the Eastern Telegraph Company had five cables from Cornwall, and at busy hours they dealt with 15,000 words per hour. There were forty cables which touched England, including the gigantic network of North American cables, and if other cables were working at the same rate they would arrive at a total of 120,000 words per hour, which was equal to 2,000 words or 12,000 letters per minute. Let them fancy this discharge of words being bombarded into ether and encountering there an equal bombardment from foreign countries. The prospect was appalling. The record of the cable enterprise since 1850, when the first little cable was laid across the English Channel, and since about forty years ago when the first cable was laid across the North Atlantic, was a great one, and when it was considered that these developments were brought about chiefly, if not entirely, by the enterprise of their own countrymen, the record was one of which they might well feel proud.

Nobody will be inclined to quarrel with these statements, but we hope that we may in time be equally proud of wireless telegraphy, which is likely to prove of incalculable service, in directions not necessarily opposed to the cable companies. An instance of its utility to the mariner was recently afforded by the accident to the American steamer *Kroonland*, *en route* for New York, which disabled her steering gear about 130 miles west of the Fastnet, and had to put back to Queenstown.

The saloon passengers speak in the highest terms of praise of the utility of the Marconi wireless telegraphy with which the liner is fitted, and of the facility with which, when the accident occurred, the passengers were able to communicate with their friends in England, Scotland, and the Continent, and even America, and get replies before the Irish coast was sighted. The accident occurred in the middle of the day, and communication was at once made with the Marconi station at Crookhaven. Captain Doxrud was enabled accordingly to send messages to the chief agents of the American Line at Antwerp stating the nature of the damage to the steering gear of the steamer, and that he would have to abandon the idea of prosecuting the western voyage. Within an hour and a half a message was received by the captain from the agents instructing him what to do, and at once the *Kroonland* was headed for Queenstown. Three-fourths of the total number of the saloon passengers and a goodly number of the second cabin sent messages to their friends in various parts of the world, and replies were received even from the Continent before the Fastnet was sighted.

Life and Limb on American Railways.

The Interstate Commerce Commission has just issued its quarterly accident statistics for the period ending June 30th, 1903, and to quote a leading American journal, it certainly "cannot be said that they are in any sense gratifying."

"As for the totals—over 3,500 killed outright and nearly 46,000 injured, only the casualty records of the greatest battles in history will serve as a comparison."

The figures, as compared with the previous year, show a melancholy increase all along the line, though it is only fair to say that this is partly to be ascribed to the growth of traffic, and particularly to the presence in the service of an usually large proportion of inexperienced men, who have been employed, owing to the unprecented volume of traffic. The actual figures are as follows:—

	1903.		1902.	
	Killed.	Injured.	Killed.	Injured.
Passengers—				
In train accidents ...	164	4,424	167	3,586
Other causes	157	2,549	136	2,503
Total	321	6,973	303	6,089
Employees—				
In train accidents ...	895	6,440	607	5,046
In coupling accidents ...	253	2,788	143	2,113
Overhead obstruction, etc.	93	992	104	1,070
Falling from cars, etc. ...	678	8,025	537	6,867
Other causes	1,314	20,759	1,035	18,615
Total	3,233	39,004	2,516	33,711
Grand total ...	3,554	45,977	2,819	39,800

It is shown that only one in three of those killed, and about one in four of those injured, were in train accidents. Falling from moving trains or casualties while getting on or off, is the most frequent cause of death to both passengers and employees in the States. During the year under review, both collisions and derailments increased in number greatly as compared with 1902.

A Blue-Book has been issued containing returns of accidents and casualties as reported to the Board of Trade by the several railway companies in the United Kingdom during the six months ended June 30th, 1903, together with reports of the inspecting officers, assistant inspecting officers, and sub-inspectors of the Railway Department to the Board of Trade upon certain accidents which were inquired into. Accidents to trains, rolling stock, permanent way, etc., caused the death of four persons and injury to 368 persons. The total number of personal accidents reported to the Board of Trade by the several companies during the six months amounted to 607 persons killed and 8,683 injured.

The New Imperial College of Technology.

The annual dinner of the Institution of Mining and Metallurgy, afforded the President of that Institution (Mr. Henning Jennings) an opportunity of dealing with the technical education question, and of showing the part which that institution has taken and is taking in connection with the movement. Explaining the circumstances under which the Council are centring their advice and aid upon the Royal School of Mines, he said they felt that the work of reorganisation should not be done on a little patchwork system, but on great broad lines, and thus they had welcomed the great scheme now on foot for the organisation of a great new Imperial College of Technology at South Kensington. They felt satisfied that if such a scheme were established, the claims of the strengthened and perfected Royal School of Mines for recognition could not be ignored, and that it would not be blotted out, but only strengthened and vivified. They also realise that at the present time the organisers of the larger scheme could not be assisted by detailed discussion or advice from them, as it was evident that the first step to be taken was to properly arrange the managerial and finanical lines with the Government donors, and the amalgamated educational institutions. They understood that, when this organisation was complete, detailed technical advice would be eagerly sought, from all other professional societies which the various branches of the new college might embrace. Thus they felt that the most efficient way in which they could help forward this great, good cause at present was by having faith and patience.

In the same way public subscriptions to the Bessemer Memorial had not yet been energetically solicited, as it was not considered well to do so until the main lines of the larger scheme with which it was combined had been more defined. The interest in the movement, though at present allowed to lie dormant, was still intense and vital, and that institution had shown its belief in the final outcome of the scheme by promising from its funds an appropriation of one thousand guineas.

He would in no way attempt to set forth the relative statistics connected with the technical education of Germany, the United States, and this country. This had already been done by abler voices and pens than his. The point, however, that he desired to emphasise regarding these statistics was this: that by creating one great technical centre for higher education in this country, they need not fear that they should be overdoing the business in comparison with other countries; in fact, in the case of the London Polytechnic schools, which had done and were doing such great good work for the artisan classes by their wonderfully efficient night school courses, the highest courses in this new college should only be regarded as a goal and prize for their best talent, and thus stimulate and not injure. Other existing technical institutions should also not be alarmed, for it seemed to him that, by focussing public interest and making a great success at one centre, they should only be recruiting interest and funds for the whole structure of technical education in the kingdom. It seemed to him that the new institution should draw its supply of students from both the struggling and the prosperous, and for this purpose scholarships and judicious aid of all kinds must be given to the struggling. The prosperous should be attracted to it, not as to a new playground, or a soft-hearted influence centre, but should be made to feel that it was a real training ground for battle, where their mental muscles could be made strong, quick, and flexible for the strenuous and exacting struggle that was before this nation in connection with industrial matters.

The Mosely Commission.

It is remarked by an influential American journal that the recent visit of the British Commission investigating American methods of technical education brings to the front a very serious question as to the value of that which they have found—"That technical instruction in England is in a highly unsatisfactory state admits of little doubt; it is quite certain also that the Commission discovered here some admirable institutions, but did they find a well-defined method of education which might fairly be said to be common to American technical schools? We think not, and on the contrary, if their investigations were at all as thorough as they were intended to be, they assuredly found that American institutions were on all sorts of planes of usefulness and representing all sorts of educational ideals. English technical instruction is essentially a development of the trade-school idea, very useful in itself, but far from being all-inclusive in its functions. Here the trade school as such is almost an unknown quantity, and so far as it here exists is of comparatively recent growth. That it may be useful when intelligently managed the correspondence schools which have assumed some of its functions bear witness; but they cannot be regarded as a sequent part of our general educational system, which is based as regards technical instruction, on the small university using that term in its American signification of an institution in which all sorts of things are taught. The main work of technical instruction in this country is done by the 'land-grant' colleges under State supervision and founded originally to provide instruction in 'agriculture and the mechanic arts.'

"In many instances the instruction in agriculture has been separated from that in the mechanic arts, and the latter has been merged in the general work of a State University; but it is an impressive fact that technical study has been in every State of the Union backed up by a strong local appreciation of its necessity. It is in response to this sentiment that courses in engineering have been developed, and because of its representation of local necessities that they have taken the various forms in which they now appear."

Mr. R. H. Thwaite in America.

Mr. R. H. Thwaite, during his stay in America, has been giving the readers of the *Iron Age* the benefit of some data relative to his latest type of Blast Furnace Gas Cleaning Plant.

The gas is led to a special form of washer of the simplest construction, this being equipped with a water seal, which not only enables the deposited dirt to be removed at any time, but also acts as a ready outlet of escape in the case of sudden rushes of gas. This apparatus reduces the temperature of the gases, and a considerable proportion of the water suspended in them is condensed. It is so arranged as to compel the gases to flow uniformly and repeatedly through the water, this being effected by the action of a centrifugal fan, which is sufficiently powerful to establish and maintain a 10-in. suction. From the washer the gas flows into an atmospheric tubular cooler, which may act as a recuperator of hot air if that should be required for any purpose. Usually, however, the tubes are exposed merely to the cooling influence of the atmosphere. They are open on the top and at the bottom, so that they can be readily cleaned by either mechanical means or, what is generally sufficient, by flushing them with water from an upper tank. This tank combines the two sets of tubes through which the gas flows first in an upward and then in a downward direction. From this apparatus the gas enters the centrifugal fan which is so arranged that any dirt which accumulates can be washed out readily. The fan not only draws the gas from the two elements of the plant already described, but it also forces the gas through two additional filtration elements for the sake of future purification. These act also as safety valves; that is to say, if, due to a fall of the burden or to explosions in the furnace—not uncommon occurrences—there is an abnormal quantity of dust in the gas. If it were not for the filtration elements this dust would to some extent gain access to the engine and create serious trouble. The filtration elements, which consist of a duplicate set of coke scrubbers and sawdust scrubbers, stop this dust, so that the gas when it enters the holder is pure and almost dry. The last element in the series is the governor holder, which establishes a constant pressure, regulating the supply of gas to the engine.

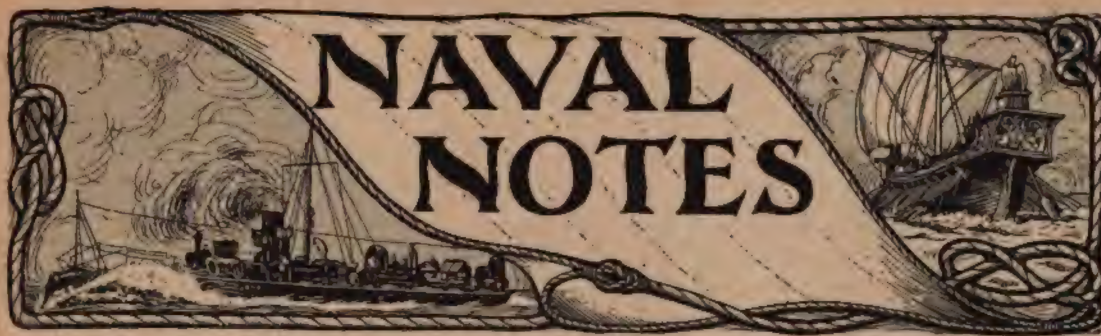
The Author of "De Magnete."

The tercentenary of the death of Dr. Gilbert, of Colchester, gave the Institute of Electrical Engineers an opportunity of doing honour to the memory of a man whose researches, forgotten by many, entitle him to be called the father of electrical science. On the 10th ult. a very interesting picture, by Mr. A. Ackland Hunt, showing Dr. Gilbert experimenting before Queen Elizabeth and her Court was formally presented by the Institution to the Borough of Colchester. Professor Silvanus Thompson so happily summed up the work of Dr. Gilbert that we cannot do better than quote his remarks direct. "Electricians," he said, "owed an enormous debt of gratitude to Gilbert, who for them was pre-eminent among all the great men of Elizabeth's time. There had been Statesmen before Cecil, dramatists before Shakespeare, and philosophers before Bacon, but before Gilbert there was no electrician. He claimed admiration as the founder of electricity, and also of terrestrial magnetism; of the latter science, proceeding by the method of experiment, he laid the foundation in his book 'De Magnete,' and drew the inference that the earth itself was a magnet. In spite of the claims of a busy life as a physician, he devoted much time and money to scientific work. Astronomy owed three things to him—advocacy of the views of Copernicus in England, the conclusion that the fixed stars could not all be at the same distance from the earth, and the first known map of the moon. He also advanced the science of navigation. He was born at 2.30 p.m. on May 24th, 1544, at Colchester, in a house that was still standing, and for aught they knew to the contrary his death also took place in it on December 10th, 1603 (N.S.). Within a few yards of that house, which should be the Mecca of electricians, his bones were laid in the Church of Holy Trinity, where there was a monumental tablet to his memory."

The Mayor of Colchester assured the President and members of the Institute that the picture would be suitably hung upon the walls of the Town Hall of Gilbert's native town.

The Late Sir Frederick Bramwell.

It is not easy within the limits of a paragraph to pay a fitting tribute to the unique and striking personality of the late Sir Frederick Bramwell, whose active and useful career ended on November 30th. His sterling personal characteristics, genial temperament, and ready wit, may unhappily fade from the mind with the lapse of time, but he will long be remembered as the foremost arbitrator of the day in engineering matters—especially those affecting the mechanical engineer. The late baronet was born in 1818—the year which witnessed the founding of the Institution of Civil Engineers. His successful career extended over the best part of a century, distinguished above all others as the age of mechanical engineering. It is impossible to look back upon such a life without wonderment at the vitality of the man, the wide ramifications of his interests and the amount of work he was able to achieve in the half century which elapsed between 1853, when he commenced business on his own account, and the time of his demise. Few can claim the honour of having been president of three such institutions as the Institution of Civil Engineers, the Institution of Mechanical Engineers, and the British Association. His abilities were widely recognised both in the profession and out of it. He held the honorary degree of D.C.L. from the Universities of Oxford and Durham, and that of LL.D. from Cambridge and McGill. Other prominent features in the life of the late Baronet were, his election as Fellow of the Royal Society in 1873, his appointment on the Ordnance Committee in 1881, his appointment as Honorary Secretary of the Royal Institution in 1885, his Knighthood by Queen Victoria in 1881, and the baronetcy which was bestowed upon him in 1889.



MONTHLY NOTES ON NAVAL PROGRESS IN CONSTRUCTION AND ARMAMENT.

BY

N. I. D.

THE purchase by this country of the two battleships *Libertad* and *Constitucion* building in this country for Chili, and the decision of the Admiralty to use the design of the *King Edward VII.* class for the three battleships to be built in the Government dockyards, has aroused a further discussion upon design and cognate matters. In this Magazine, about this time last year, I discussed the relative importance of the qualities and attributes required in design, whether for battleship, cruiser, or other purposes, and showed how they should be combined to make up what I called battleworthiness. It is well to remember, when discussing questions of design, that experts are not agreed altogether as to the exact relation that these qualities or attributes should bear to one another in the various classes of vessels. This is not to say that there is no general consensus of view as to the predominance of certain qualities for certain classes, but rather that the divergency of opinion is one of relative quantity. Everyone, it may be assumed, would place the quality of offence first in a battleship design, whereas in a cruiser speed would be the first quality looked for by many. It is true that a certain school have recently shown an inclination to place speed in a battleship more prominently forward than had previously been the case. But it seems fairly obvious that it is of no great account to be able to bring your ship speedily to the point of action if, when she arrives there, she is inferior in power of offence to the vessel by which she is to be opposed. Similarly seaworthiness, which I take to be a combination of elements including steadiness as a gun platform, and a reasonable amount of habitability for the crew as well as merely sea keeping ability, has of recent years taken a higher place than formerly. The contrast presented by the outward appearance of our modern battleships, and those for example of the "Admiral" class demonstrates clearly the movement in this direction. It has been said, and with some truth, that in endeavouring to obtain the greatest possible steadiness as a gun platform, and at the same time the greatest amount of seaworthiness, the naval constructor has to reconcile two fundamentally opposed qualities, since the more lively vessel is generally the more stable ship. In some tables, which I give below, I have endeavoured to show, by means of figures, the qualities of various classes of battleships. And although it would be a mistake, as Sir William White has so lucidly and conclusively demonstrated, to use these figures alone for the purpose of comparing one class of ship with another, they should at least be valuable for the purpose of indicating the trend of opinion in the various countries.

The method followed in the tables given below is to arrange the different types in order of age, the date given being that at which the vessels were presumably designed. It has seemed better to use this date than that of launch or completion, because it is obvious that unless modifications are made in the elements of the vessel during building, this is the right date to use for purposes of comparing design. Secondly, displacement is a measure of capacity; it is obvious that where there is large discrepancy in displacement there must have been sacrifices of some kind in the smaller vessel, and moreover, if in the smaller vessel there is also found to be a preponderance of any particular attribute over the corresponding quality in the larger vessel, so much greater must have been the sacrifice in other directions. Bearing on this question three important factors require consideration. These are coal capacity, coal consumption and speed. The coal capacity of a type is difficult to determine with precision. We are generally given two amounts: the bunker capacity at the normal displacement of the vessel and a larger amount, which is generally described as the maximum, and which, if the vessel carried it, would presumably increase her displacement and therefore affect both her consumption and speed. The coal consumption at various speeds would, if included, have considerably increased the space required for the tables. It has, therefore, been omitted, but it should certainly be taken into account in comparing design. The speed given in every case is that for which the ship and her machinery was designed, except where such speed was not attained on trial. Some vessels have, doubtless, exceeded their designed speed—the *Libertad*, for example, is reported to have attained over twenty knots—but to introduce these trial speeds would require also a description of the circumstances and conditions under which they were accomplished. In regard to armour, the maximum on barbettes and secondary batteries has been placed in the tables, but here, again, merely an indication is given, for no real comparison of defensive power can be made, until the amount of area protected and the total weight assigned to protection are accurately known. Turning to gun power, instead of enumerating the guns, the weight of broadside has been substituted. This, however, should be supplemented, not only by the range and penetration of the guns, but by data very difficult to obtain respecting the supply of ammunition, and

the rate of aimed fire and the nature of the protection afforded to each character of ordnance.

The above remarks should indicate how difficult it is merely by means of statistical tables, to arrive at any real comparison of design; the point aimed at has rather been to show the line of relative improvement and the tendency to advance in one or another quality among the many which are considered desirable and even essential.

GREAT BRITAIN.

BATTLESHIPS.

Name and Programme.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broadside.
	tons.	*tons.*	*knots.*	*in.*	*lbs.*
London .. .. (1898–1899)	15,000	900 / 2,000	18.0	12 / 6	4,112
Duncan .. .. (1899–1900)	14,000	900 / 2,000	19.0	11 / 6	4,075
Libertad .. .. (1899–1900)	11,800	800 / 2,000	19.0	10 / 7	3,487
Queen .. .. (1900–1901)	15,000	900 / 2,100	18.0	12 / 6	4,112
King Edward VII. (1901–1902)	16,350	950 / 2,000	18.5	12 / 7	4,747

From the above figures it is shown that the displacement of our battleships is gradually increasing, and with it an increase in all the other attributes of the ship. The contrast between the displacement of the *Libertad* and the other British ships is very striking, but it will be seen that it carries with it a great diminution in the weight of broadside and presumably in other matters not so apparent. Comparing the weight of metal thrown on one broadside by the *Libertad* and the *King Edward VII.*, it is noteworthy that if we subtract from both ships the heaviest guns, we find that the broadside of the secondary battery of the *King Edward*, consisting of two 9·2-in., five 6-in., and seven 3-in. guns, gives us a total of 1,347 lbs., whereas in the *Libertad* the secondary battery of seven 7·5-in. and seven 14-pounders, gives 1,487 lb., a difference of 140 lb. against the *King Edward*, and this difference is still more marked if the lighter guns on both sides are subtracted; then the *King Edward* can only throw 760 lb. of metal to 1,400 from the *Libertad*.

There are many other matters in connection with a comparison between the *Libertad* and the Admiralty designs which require elucidation. For example, an important point concerns the height at which the 7·5-in. guns of the *Libertad* are carried above water, and the possibility of their use in a heavy seaway, the length of these guns, and particularly of that portion of the chase which is outside the vessel, is considerably more than is the case with the 6-in. guns carried in English ships. Until, therefore, this ship and her sister have been tried at sea under varying conditions some uncertainty will exist about their powers of offence in certain circumstances. Doubtless, now that the Admiralty have acquired these vessels they will seize the opportunity to test them in company with vessels of Government design. In this way many important questions which have, at times, been mooted in comparisons made between British ships and ships built in this country for foreign Powers may be settled.

ARMOURED CRUISERS.

Name and Programme.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broadside.
	tons.	*tons.*	*knots.*	*in.*	*lbs.*
Cressy .. .. (1898–1899)	12,000	800 / 1,600	21.0	6 / 5	1,448
Kent .. .. (1899–1900)	9,800	800 / 1,600	23.0	5 / 4	962
Drake .. .. (1900–1901)	14,100	1,250 / 2,500	23.0	6 / 6	1,647
Devonshire .. (1901–1902)	10,700	800 / 1,600	22.25	6 / 6	975
Duke of Edinburgh (1902–1903)	13,550	1,000 / 2,500	22.0	6 / 6	2,020

As between the *Kent* and the *Devonshire* the additional displacement is principally devoted to increased protection, the difference in weight of broadside being small. On the other hand the *Duke of Edinburgh*, with a slightly less displacement than the *Drake*, has increased protection given to the ship and an increase in gun power, with a possible loss in speed although it is hoped that the result on trial will be better than that estimated.

As a result of the recent manœuvres we have been told that the Admiralty incline to a policy of eliminating all the smaller classes of cruisers, retaining the heavy armoured ships of which the *Duke of Edinburgh* is the latest expression, and then descending to the class of scouts which are yet under construction. It is evident, looking at the above tables, that greater gun power is now considered a desideratum.

FRANCE.

BATTLESHIPS.

Name.	Displacement	Coal Capacity	Speed.	Armour.	Weight of Broadside
	tons.	*tons.*	*knots.*	*in.*	*lbs.*
Jéna .. .. (1897-1898)	12,052	820 / 1,100	18.0	12 / 4	3,42[illegible]
Suffren .. .. (1898-1899)	12,728	820 / 1,150	18.0	12 / 5	3,52[illegible]
République .. (1901-1902)	14,865	900 / 1,850	18.0	12 / 6	3,8[illegible]
Liberté .. .. (1902-1903)	14,927	900 / 1,850	18.0	12 / 6	4,01[illegible]

In France the displacement of the battleships is on an increase, and without any corresponding advance in the other elements, with the exception of gun power. The *Liberté* class are to be armed with ten 7·6-in. guns in place of the eighteen 6·4-in. which the *République*

will carry, and an addition will be made of eight 3·9-in. The disposition of the guns is slightly different, because, instead of a couple of 6·4-in. guns in each of the six turrets, one 7·6-in. will be mounted, in each, while four others of the same calibre will be in casemates. Thus another instance is given of the little regard which is paid to homogeneity in the French fleet.

ARMOURED CRUISERS.

Name.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broadside.
	tons.	*tons.*	*knots.*	*in.*	*lbs.*
Jeanne d'Arc .. 1896	11,329	1,400 — 2,100	23.0	6 — 5	843
Montcalm .. (1897-1898)	9,517	1,020 — 1,600	21.0	6 — 4	838
Kleber .. (1898-1899)	7,700	880 — 1,200	21.0	3½	657
Marseillaise .. (1899-1900)	10,014	970 — 1,590	21.0	7½ — 6¼	869
Victor Hugo .. (1901-1902)	12,550	1,320 — 2,100	22.0	5 — 5	1,554
Ernest Renan .. (1902-1903)	13,562	2,300	23.0	6 — 6	1,345

As compared with the British cruisers the French armoured ships show an approximation in point of displacement and in speed, but the weight of broadside fire of the latest type is considerably less than that of the *Duke of Edinburgh* of about the same tonnage. This is owing to the fact that the British vessels carry six 9·2-in. guns, whereas the *Ernest Renan* is only provided with two guns of similar calibre. Nor is the balance redressed by any corresponding increase in the number of guns of smaller calibre.

GERMANY.

BATTLESHIPS.

Name.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broadside.
	tons.	*tons.*	*knots.*	*in.*	*lbs.*
Wittelsbach .. (1898-1899)	11,800	700 — 1,450	18.0	10 — 6	2,777
Braunschweig .. (1900-1901)	13,200	700 — 1,600	18.0	10 — 5½	3,028

In point of age and displacement, the *Wittelsbach* class may be compared with the *Libertad*, but the latter ship throws a heavier weight of metal owing to her being provided with 7·5-in. guns in place of 5·9-in. as in the German ship. The latter also will hardly compare in point of speed with the Chilian design. In Germany, however, the same tendency occurs to increase displacement and armament, even at the sacrifice of speed and protection.

ARMOURED CRUISERS.

Name.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broadside.
	tons.	*tons.*	*knots.*	*in.*	*lbs.*
Prinz Heinrich .. (1897-1898)	8,930	950 — 1,500	20.0	6 — 4	1,513
Prinz Adalbert .. (1900-1901)	9,050	950 — 1,500	21.0	6 — 4	1,816

Germany has not yet essayed the construction of many armoured cruisers, nor have those in hand shown that increase in displacement which is to be found elsewhere. But, although the tonnage of the three ships of the *Prinz Adalbert* class is about the same as that of the British *Kent*, the German armament works out to nearly twice the weight of that of the English vessel, her heaviest guns being of 8·2-in. calibre, and those of the second size, 5·9-in. instead of 3-in., as in the English ship. This increase in weight of broadside has been obtained without apparently a diminution of protection, but probably with a loss in speed.

RUSSIA.

BATTLESHIPS.

Name.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broadside.
	tons.	*tons.*	*knots.*	*in.*	*lbs.*
Retvisan .. (1897-1898)	12,700	1,000 — 2,000	18	1 — 5	3,434
Tavritchesky .. (1897-1898)	12,500	670	18	12 — 5	3,676
Tsarevitch .. (1898-1899)	13,100	900 — 1,350	18	11 — 6¼	3,516
Borodino .. (1898-1899)	13,600	1,250 — 2,000	18	10 — 6	3,516
Joann Zlatoust ..	12,500	—	18	11	4,128
Pavel I. .. (1902-1903)	16,350	—	18	—	—

According to the most recent reports about the new Russian battleships, those which are to be built in the Baltic will be very similar in design to that of the *Edward VII.* class. In tonnage and in speed they are apparently to be alike, but no trustworthy particulars in regard to armament have yet come to hand. Of the vessels to be built in the Black Sea, they are apparently with some modifications, similar in design to the *Tavritchesky*. The condition of service of the vessels built in the Black Sea doubtless finds expression in the design chosen for those ships. If, as is likely, the British Government is in possession of the design chosen for the *Imperator Pavel I.*, it may be that this knowledge had its effect upon the decision recently arrived at to build three more ships of the *King Edward VII.* class.

ARMOURED CRUISERS.

Name.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broadside.
	tons.	*tons.*	*knots.*	*in.*	*lbs.*
Gromoboi .. (1897-1898)	12,336	800 —— 2,500	20	6 — 4½	1,197*
Bayan .. .. (1898-1899)	7,800	750 —— 1,100	22	7 — 3	952
New Design .. (1903-1904)	—	—	—	—	—

* Does not include six 4·7-in. guns which one authority says are carried but which others omit.

Particulars of the design of the new armoured cruiser which Russia is reported to be about to build in the Baltic are yet wanting. It is noteworthy, however, of the *Bayan*, that on a displacement somewhat less than that of the *Kent*, an armament is carried of two 8-in. guns and eight 6-in. as against the fourteen 6-in. in the English ship. The *Devonshire*, a modified *Kent*, carries a very similar armament to the Russian cruiser.

UNITED STATES.

BATTLESHIPS.

Name.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broadside.
	tons.	*tons.*	*knots.*	*in.*	*lbs.*
Maine .. .. (1898)	12,300	1,000 —— 2,000	18.6	12 — 6	4,242
New Jersey .. (1899)	14,948	900 —— 1,900	19.0	11 — 6	5,584
Connecticut .. (1902)	16,000	2,000 —— 2,200	18.0	10 — 7	5,530
Idaho .. .. (1903)	13,000	1,750 —— 2,000	16.0	12 — 10	5,309
Kansas .. .. (1903)	16,000	900 —— 2,200	18.0	12 — 10	5,530

The discussion upon design which has for some time been carried on in the United States resulted, as is well known, in two types being chosen, the smaller of which may be said to take the place of the larger armoured cruisers now building elsewhere. Another subject of controversy was the system of superposed turrets, originally tried in the *Kearsarge* class, and reappearing in the New Jersey ships. Recently it is said to have been shown that the turret structures of the *Kearsarge* and *Kentucky* are weaker than is thought to be entirely satisfactory, and, as a result, the similar structures of the New Jersey class will be strengthened. But it is in point of weight of broadside that the American ships are most conspicuous. How this is obtained on the displacement and without loss of speed or neglect of protection, has not been explained. Possibly, an investigation and comparison with our standards of the elements brought together in the *Libertad* may throw light on this matter.

ARMOURED CRUISERS.

Name.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broadside.
	tons.	*tons.*	*knots.*	*in.*	*lbs.*
Milwaukee .. (1900)	9,700	650 —— 1,500	22.0	4 — 4	926
California .. (1900)	13,680	900 —— 2,000	22.0	6 — 5	1,826
Tennessee .. .. (1902)	1,4500	900 —— 2,000	22.0	9 — 5	2,954

In point of age, the *Tennessee* class compares with the British *Duke of Edinburgh*. With a displacement one thousand tons heavier and considerably stronger protection for the heavy guns, the weight of broadside is more than 900 lb. in excess of that thrown by the English ship. The *Tennessee* carries four 10-in. guns to the *Duke of Edinburgh's* six 9·2-in., but the disparity in this respect is made up by an additional six 6-in. guns in the United States cruiser as well as twenty-two 3-in. I have indicated above other points for comparison with foreign vessels, but the gradual progress in the American designs is clearly indicated by the figures in this table.

JAPAN.

BATTLESHIPS.

Name.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broadside.
	tons.	*tons.*	*knots.*	*in.*	*lbs.*
Hatsuse .. .. (1896)	15,000	1,100 —— 1,400	18.0	14 — 6	4,240
Asahi .. .. (1896)	15,200	1,000 —— 1,400	18.0	14 — 6	4,240
Mikasa .. .. (1897)	15,200	700 —— 1,500	18.0	14 — 6	4,225

It is unnecessary to add to the information afforded above. We are told that a new programme is in course of consideration, if, indeed, it is not already settled, and we may be sure that the Japanese will not fail to take advantage of all that has been learnt by other countries.

ARMOURED CRUISERS.

Name.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broadside.
	tons.	*tons.*	*ons.*	*in.*	*lbs.*
Asama .. .. (1897)	9,750	600 —— 1,200	22.0	6 — 6	3,368
Yakumo .. .. (1897)	9,850	600 —— 1,100	20.0	6 — 6	3,368
Azuma .. .. (1898)	9,436	—	21.0	6 — 6	3,368
Idzumo .. .. (1898)	9,800	700 —— 1,600	20.75	6 — 6	3,368

SHIPBUILDING NEWS.

The Outlook.

By the time these lines are in print the shipbuilding returns of the year will have been completed. But while we write the figures are not available, so comment on the business of the past year must be deferred until next month. From the returns we have received up to the end of November it seems evident that the output of the shipyards in 1903 will prove to have been considerably short of that of 1902, by, we should say, not less than 100,000 tons. Perhaps even as much as 200,000 tons, inasmuch as the Scotch record, up to the end of November, was 88,500 tons short of the corresponding eleven months. And Scotland all last year was much busier than the other shipbuilding centres. Latterly, however, it did seem as if more new contracts (and they are not very numerous, after all) have been booked on the North-East of England than by the Scotch shipbuilders. But it is noteworthy that many of the Scotch shipbuilders do not report the contracts they receive for small craft, which go to swell the year's tonnage without appearing in the monthly reports of orders booked. Thus it is that the year's total usually comes out above the estimates. Again, Lloyds' official returns of the vessels "under construction" may include a lot of the same tonnage in the reports of two years. There are, for instance, cases of vessels launched in 1902 which might have been completed and sent to sea in that year, but which have been laid up, unfinished, in builders' hands. Such vessels will appear in the tonnage "under construction" in both years, though not in the builders' returns of launches.

Expected Orders Diverted.

The year 1904, then, opens with no great promise in the shipbuilding world. Some of the large yards specially equipped for the building of large liners and warships will be tolerably well off for work for some months to come, even if they book no new contracts, but even with them there is the disappointment caused by the decision of the Admiralty to build the three battleships of the 1903 Naval Programme in the Dockyards, instead of by contract as originally intended. Thus, three yards are deprived of expected orders. However, three other ships which were to have been laid down in the dockyards in 1904 will, in place of them, be given out to contract, the present change having been made to keep the staff of the Dockyards together and well engaged. The ordinary yards given up to the production of cargo boats and smaller craft will be poorly employed, and it is to be feared that some of them will have to be closed altogether if there is not an access of new orders soon. And of that there is not much probability in the state of the freight market and the growing depression in general trade. But one can never tell. A political turn-up in the Far East or in South America may cause a sudden demand for shipping. There are, happily, no symptoms of labour disturbances at the opening of the year. The men in the East Coast shipyards seem to have made a virtue of necessity and accepted the reductions of five per cent. asked by the employers last month, and the men in the marine engine shops now forbear to press for an advance in view of the slackness in other branches of engineering in which, a while ago, they had opportunity of alternative employment.

Shipbuilding Costs.

Shipbuilding costs are, of course, down a good deal as compared with the beginning of last year. Steel ship plates have been reduced to £5 10s. in the North of England and in Scotland, and angles are down to £5 to £5 7s. 6d. With cheap pig iron (and hematite is lower proportionally than ordinary iron), and with the probability of American and German plates being soon on offer, the prospect is rather of cheaper shipbuilding, yet somehow shipowners do not look so much for lower costs, which they admit to be low already, as to better prospective employment for their vessels. Steamers of large size have recently been contracted for at as low as £5 12s. 6d. per ton deadweight, a price on which the builders can have no margin. It is probable, however, that there will be some run on turbine steamers this year. The example set by the Allan line (whose second turbine boat is to be built by Messrs. Alexander Stephen and Sons, Ltd., Linthouse, Glasgow, as a sister ship to the one being built by Messrs. Workman, Clark and Co., Belfast), will doubtless be followed. Indeed, during the last month of 1903 Messrs. Wm. Denny and Bros., of Dumbarton, had on hand contracts for five large turbine steamers for the Colonies.

Increase of Maritime Disasters.

The past year has been a pretty severe one upon underwriters, not only in this country but also in France and Germany. Indeed, so much insurance has been transferred to this country of late that it almost looks as if French and German underwriters were scared. The Bureau Veritas have published a list of maritime disasters reported during the month of October concerning all flags. Of sailing vessels reported lost, there were 11 American, 1 Argentine, 2 Brazilian, 33 British, 5 Danish, 2 Dutch, 5 French, 3 German, 3 Italian, 19 Norwegian, 1 Portuguese, 4 Russian, 1 Spanish, 12 Swedish, 3 Turkish—total 105. Of steamers reported lost there were 2 American, 2 Austrian, 17 British, 1 Chilian, 1 German, 5 Italian, 1 Japanese, 3 Norwegian, 1 Swedish—total 33. The St. Lawrence season, which closed at end of November

ast, was open in 1902 to December 8th. In 1903 the casualities were numerous in spite of the improvements in the channel which the Canadian Government have effected. There were fifteen accidents there altogether, and two of the vessels—the *Monterey* and the *Topaz*—became total wrecks. In 1902 there were eleven casualities, with no total losses, and in 1901 there were five strandings, also without total losses. In 1900 the casualties numbered five, and only four of the boats were salved. Thus, 1903 was a good deal worse than its two immediate predecessors, while it must also have been worse, from a monetary point of view, than the three years preceding 1901.

The *Baltic*.

The launch of the largest ship in the world by Messrs. Harland and Wolff, Ltd., Belfast, for the White Star Line of the Morgan Combine, was briefly alluded to in the December number of PAGE'S MAGAZINE. The *Baltic*, as she is named, is not only the largest, but is also, in many respects, the finest vessel afloat. The new vessel will have accommodation on the same lines as the *Celtic* and the *Cedric*, but more commodious. The general arrangement is similar to these vessels, a continuous shade-deck running fore and aft, with three tiers of deck houses and two promenade decks above. On the upper promenade deck is the first-class smoking-room and library, and the two houses below contain the deck state-rooms. The first-class dining saloon is on the upper deck, and all the first-class accommodation is amidships. Immediately abaft the first-class is the second-class accommodation, and also a comfortable smoking-room and library for this class. The third-class passengers are provided for abaft the second-class, and to a limited extent at the fore end of the vessel. A great feature in this accommodation is the large number of state-rooms of two, three and four berths, and the commodious and comfortable dining-rooms. There is accommodation for nearly three thousand passengers, besides quarters for a crew of about three hundred and fifty. The decorations are artistic and the appointments handsome and luxurious. In addition to the ordinary state-rooms, there are suits of bed, sitting and bath-rooms, also single-berth state-rooms. As in the other large steamers of this type, one of the most notable features in the *Baltic* is the grand dining saloon, situated on the upper deck, and extending the full width of the ship, 75 ft. It contains seating accommodation for three hundred and seventy people. The first-class smoking-room and library are also fine apartments, and the second-class public rooms are elegant and comfortable. The heating and ventilating arrangements of the ship are most complete, and the *Baltic* will be fitted with winches and other loading and discharging arrangements of the latest and most efficient type. There will be large refrigerating chambers for the carriage of chilled beef, the machines for working these being on the CO_2 method. The engines are arranged on the "balanced" principle, which practically does away with vibration. The twin engines and twin screws afford another element of safety to the ship and passengers, and the possibility of danger is reduced to a minimum. The *Baltic* is to be ready for the summer service of the White Star Line.

Shipbuilding Ancient and Modern.

Mr. John Ward, F.S.A., in his remarkably complete book, "Greek Coins and Their Parent Cities,"* has an interesting reference to the shipbuilding of the Ancients, as contrasted with the products of our modern yards. "There is," he says, "a description of the wonderful ship built by Archimedes in the pages of Athenæus, an historian or anecdote-monger of Naucratis. This ship was so large that, like the *Great Eastern* of modern times, she 'stuck' when they tried to launch her. Whereupon Archimedes devised his screw, used it as a means of propulsion, and launched the huge vessel easily. But the strain had made the big ship leak, and she became water-logged. Another development of his wondrous screw, and she was quickly pumped dry, and the leaks, no doubt, were caulked securely. This ship had real gardens of great extent, a wrestling ground, rooms full of pictures and statuary, floors of tesselated marble decorated with subjects from Homer. It possessed barracks for soldiers and stabling for cavalry, and carried, besides an enormous cargo of grain, eight fortified towers. When it was completed there was no harbour in Sicily fit to hold it, and so Hieron made a present of the costly toy to Ptolemy Philadelphus of Egypt. We, unfortunately, do not know its measurements, but it must have been a monster, and was the greatest ship the world had ever seen. Ptolemy had also built a great vessel, of which we have measurements, but the Syracusan ship eclipsed it. Ptolemy's ship was 425 feet long and 60 feet beam, 72 feet deep, and seems to have been a vessel of war; while Hieron's was intended to carry grain—there was a famine in Egypt, and he sent the ship, full of grain, to Alexandria.

It is worth noting the size of the *Celtic*, the greatest ship of our time, built in Belfast in 1901.* Its designer, the Right Hon. W. J. Pirrie, LL.D., has given me the following particulars: Length, 700 feet; breadth, 75 feet; depth, 49 feet. The 'displacement,' when at full load draught, is 37,700 tons. Messrs. Harland and Wolff have not as yet introduced gardens, statuary, or wrestling grounds, into their vessels, but, no doubt, those may come in time."

Palmer Shipbuilding Yard.

The ever-increasing dimensions of modern vessels have necessitated corresponding changes in the ship yards.

The Palmer Shipbuilding and Iron Company have lately completed the work of lengthening their berths. They have rearranged their engine-shops, thus enabling them to add the space hitherto occupied by the machine-shop to the shipyard, while new shops for joiners and cabinet makers have replaced the buildings destroyed by fir[e]. These will rank among the finest in the world.

The building, which is in three storeys, has a length of 196 ft., the sawpit underneath being 70 ft. long, 68 ft. wide, and 10 ft. deep. A new and spacious erecting shop has been constructed, with every facility for dealing with an increased volume of work.

The *Armadale Castle*.

The Union Castle Liner *Armadale Castle*, one of the largest mail steamers built on the Clyde, recently sailed on her first voyage to South Africa, having completed a series of satisfactory speed trials. The new vessel possesses a gross tonnage of 12,973; her horse-power is 12,500; and her speed will be some 17 knots, although she is capable of doing more; while the vessel has been very luxuriously fitted, so that first-class passengers *en route* for South Africa may lack no material comfort. Thorough provision has also been made for the needs of second and third-class passengers.

The *Kenilworth Castle*, a sister ship to the *Armadale*, is being built by Messrs. Harland and Wolff.

* Published by John Murray. 25s. net.

* This designation was correct when the volume first appeared The s.s. *Baltic* now holds the record.—ED.

ELECTRICAL AFFAIRS.

BY

E. KILBURN SCOTT, M.I.E.E., A.M.Inst.C.E.

An Electrical Method of Straightening Wire.

Amongst the various ingenious temporary expedients which the writer has seen employed in electrical works he calls to mind a method of straightening badly kinked wire which is probably unique. Some old armature wire had been thrown on one side as only fit for the scrap-bin, but it happened to be just the gauge required for a particular purpose in the test-room. The following method was therefore adopted to straighten it: One end was attached to a wooden bench and the other fastened to a stout piece of wood which was held by an assistant. A large current was then sent momentarily through the wire from a set of accumulators and at the same moment the assistant gave it a good sharp pull, the result being a beautifully straight piece of wire. It was no doubt reduced in diameter, but so slightly as to be practically immeasurable.

Reducing Size of Copper Wire.

There is just a possibility that the above method could be employed for reducing the gauge of copper wire, because whatever change takes place in the diameter will be equal right through the full length of wire. In case anyone thinks of patenting the idea, the writer may say it was employed at the Electric Construction Company quite six years ago.

It may be mentioned that it is a very real convenience to be able to reduce the gauge of wire occasionally. In large dynamo manufacture, for example, it often happens that in the larger gauges of shunt wire the proper diameter to give the requisite number of ampère turns comes between two standard gauges. The usual course under these circumstances is to wind the coil with two sizes, that is the next sizes larger and smaller, proportioning the turns of each for the required resistance. There is an obvious objection to this in that the joint in the interior of the coil is a possible source of trouble, and it is also so easy for the winder to put on an incorrect number of turns.

Waste of Copper Wire in Electrical Factories.

Amongst the other economies which might be effected in a dynamo manufacturing works is the using up of old material, such as armature and transformer iron, and particularly copper wire, etc. The latter is always a source of great loss; for example a field coil will be wound, and after being varnished and dried, the cotton covering breaks down under test. I have actually seen such wire carelessly unwound, quite spoiling it for use again and put in the copper scrap-bin. As it cost probably over a 1s. a pound, and as scrap only fetched 3d. a pound there was naturally an enormous loss at the end of the year. Nowadays, of course, such wire will, in many cases, be carefully unwound, stripped of its insulation, and then re-covered. Every dynamo works worth the name should have a stripping and cotton covering machine.

Magnetic Steel Stampings.

The using over again of mild steel stampings for armatures, transformers, etc., is not easily dealt with, because the design of dynamo machines changes so rapidly. Now that sizes are becoming more standardised, however, it may be possible to arrange to use such stampings over again, after they have been well annealed.

In the case of static transformers, it is recognised that after a few years it pays to dismantle the transformer core, and carefully anneal the stampings so as to bring them back to their original hysteretic state. For, whatever statements transformer manufacturers and other may put forward as to iron being obtainable which will not show ageing loss, it is a moral certainty that every transformer must deteriorate in time. Of course, some iron goes off more rapidly than others; in fact, there seems to be much uncertainty about the whole question of magnetic steel or iron.

It seems to the writer that this and other similar investigations should be undertaken by the Institution of Electrical Engineers. Such activity would be more in keeping with the Institution than aping at Trades Unionism by circularising Town Clerks on questions of what is and is not etiquette.

Wanted a New Steel.

It is a well-known fact in the building trades that certain kinds of stone have the valuable property of being easily worked when freshly quarried, and which become quite hard after they have weathered some time. Other natural materials, such as slate for example, appear to possess something of this property, and the writer is not sure that it cannot be traced to the metals present in the material. Now why should not steel or metals of similar nature be invented which would be capable of being easily worked, but which would improve in strength and rigidity after having been exposed to air or water, or say by being temporarily enclosed in the fumes of certain gases?

The "Electrically Driven" Centrifugal Pump.

The development of the design and rise of the centrifugal pump to its present position of importance has synchronised almost exactly with the rise of the electric motor, and it is interesting to note that they are both simple *rotative* pieces of mechanism, and essentially built for operation at high speed.

When coupled together the two make an exceedingly neat unit taking up little space for the power developed and requiring practically no attention. At the same time the possibilities of the electrically driven centrifugal pump do not seem to be fully appreciated, as is shown, for example, by the employment of ram pumps where centrifugals, working in series, would do quite as well and be much cheaper.

Without encroaching on high lift work, there is a wide field for the centrifugal pump in low lifts, such as emptying snags, filling reservoirs, moving circulating water, sewage pumping, unwatering docks, etc.

Lowering Loans on an Electric Crane.

In the three-motor electric crane, where the load is lowered on the mechanical brake, a somewhat complicated piece of mechanism is required to connect between the moving crab and the handle in the attendant's cage.

This can be avoided if the regenerative idea is applied and the connections so arranged that the motor can run temporarily as a dynamo, the current generated when lowering being dissipated by means of resistances. With a three-phase motor the idea is similar to that on three-phase mountain railways in Switzerland. In applying the idea to a continuous current series motor, the connections are rather more complicated, but judging by the results obtained by the Schnckert Company the system works perfectly.

One advantage of this electrical method of lowering is that the movement of the load can be adjusted with very great nicety, whereas when lowering is effected on the mechanical brake there is great danger of the load being lowered jerkily, and it is not nearly so safe.

3

IRON AND STEEL NOTES.

American Methods in the Steel Trade.

In the course of an excellent paper contributed to the West of Scotland Iron and Steel Institute, Mr. H. G. Waddie pointed out what he considered to be the real difference between the management of American Steel Mills and the British method.

The central idea of American mill practice was to get the largest possible output with the smallest pay-roll; and to attain this object all available labour-saving appliances were introduced, and continuous working, with the aid, where possible, of continuous furnaces, had brought this system of working to a stage of comparative perfection. Wherever the movement of the material through the mill was independent of physical effort, it was obvious that more work would be accomplished, as the continuous flow of material from one department to the other was only dependent on the furnace capacity. The successful introduction of labour-saving methods was dependent as much on the quality of labour employed as it was on the capital invested.

The prominence given to young men in the States was a matter of surprise to many, but he saw no reason for preference being shown to the older men irrespective of ability, and he feared this was found the case in British practice. Why, he asked, should they stick to the apprenticeship system at home?

Of what use was it to talk about bursaries and aids to pushing boys if they were to be forced to work for next to nothing during the period when they ought to be gaining a knowledge of their own value and acquiring that spirit of independence which is the feature of the American boy?

The subject of cheap production of iron and steel in the United States was not entirely due, in his opinion, to any great advance in plant or machinery, but rather to exceptionally cheap raw material, transportation, and the extensive scale on which operations were conducted.

Among other points mentioned by Mr. Waddie were, the greater remuneration offered in the States for good executive ability. Longer hours were worked, and the number of ordinary or unskilled labourers was not worth mentioning. Another feature of the American method was the distribution of the mills over a wider area of ground, while at home they were usually handicapped by the dimensions of the land at their disposal. The American mill was put down to make certain sections, and there was no endeavour to tackle every kind of steel order that might be offered. Again, wherever one went, most noticeable to the unaccustomed British ear in the mills, was the hum of the various motors at work all over the place, and why this power had taken so long to obtain a hold in the home works was a mystery.

Some Criticisms.

Mr. Waddie's paper gave rise to such an interesting discussion that we think no apology will be necessary if we devote some further space to the subject.

Mr. James Crawford remarked that with regard to machinery, and the American methods of working the same, described by Mr. Waddie, these were the elaborate appliances for carrying the material direct from the iron beds to the steel works, and turning out the finished article in the way of rails, plates, etc., all of which, they were led to believe, was done by the magic wand of the switch. He thought that when put in a technical way this read very nicely, but in actual practice it did not work out to give the best results. Anyone knew perfectly well that in taking iron direct from the blast furnace there was not only the saving of labour to be considered, but they had to know if the iron was of the right quality as regards alloys before they could get the best results. For instance, they might be saving 6d on one hand and losing 1s. 6d. on the other; the latter due to waste and defective material.

By the American methods of working great economies were claimed. Say, in producing 500 tons per day, a saving of 4s. to 5s. per ton would be effected. But if they took into account this supposed saving, and saw what it came to per annum, they would find that the American works should be able to pay 30 or 40 per cent., even if they only saved the money which they saved by labour; this without considering other conditions, such as tariffs, etc. He had worked both practices, and, to his mind, the American figures given for saving would not bear investigation.

He did not wish them to imagine that he was not in favour of economies, because improvements would

undoubtedly go on, but it was quite a different thing to adopt seeming improvements which were injurious to themselves. Besides they had to remember that a great number of the American methods adopted in this country had not proved successful.

Mr. J. Hamilton opined that there was a good deal of work done in this country by hand labour that ought to be done by machinery, and by the employment of the latter, he thought they would have very much better outputs. Everything that was reasonable in the way of improved machinery he thought they ought to adopt.

Talkers and Workers.

Mr. H. Bumby, in the course of his contribution to the discussion, said that according to American talkers — the workers know better—blast-furnace working was simply a question of putting in so many tons of air at the bottom of the furnace and so many tons of ore and fuel at the top and nothing more was required. That was the style of the American articles that came to them from the other side ; and unfortunately they sometimes believed them. The fact was that in America, or rather, at Pittsburg and its neighbourhood, with the magnificent Connellsville coke and Lake Superior ore, conditions were favourable for getting enormous outputs ; and the stipulations as to quality were not so stringent as with us. When these furnaces were copied here and they tried to make a very good pig iron out of very indifferent materials, the result was not altogether satisfactory to those who provided capital for the experiment.

Mr. P. N. Cunningham said that the Americans were undoubtedly able by electrical appliances and devices to handle large quantities of materials quickly. The application of electricity was being looked into in this country very strongly ; and he thought that this went to show that we were not altogether standing still, but that radical improvements would be made very shortly in the iron and steel business in this country.

In regard to the operation of mills in America, he thought that they had greater waste in working material from the mills than we have here. Some years ago a large amount of scrap was sent here from the United States, a large proportion of which, he considered, was quite capable of being rolled into good material.

Mr. W. G. Turnbull thought that there was not much future for water power in Scotland, especially for iron and steel works. He was of opinion that the best future for the manufacture of steel was in blast furnace and steel works in combination, running the molten metal direct from the blast furnace to the steel-melting furnaces, and utilising the waste gases from the blast furnaces in gas engines for not only blowing purposes, but for the distribution of electrical power. With regard to Mr. Waddie's remarks about the apprentice system, he thought that there was now a feeling amongst many of the leading engineers that an apprenticeship of five years was unnecessarily long, and many of the best employers were now making arrangements that their apprentices should have six months' practical training in the workshop and six months' technical training at college during the year ; in other words, 2½ years' practical and 2½ years' technical training during the apprenticeship, which he thought would be an improvement on the preent systems and produce a much better class of managers.

Open-Hearth Basic Steel.

Before the same Society Mr. G. A. Wilson read an interesting paper entitled "Some Practical Hints on the Manufacture of Open-Hearth Basic Steel."

Discussing the direct or hot-metal processes, he remarked that there were three different systems at present in practice—namely, the Talbot continuous process, which was at work at the Frodingham Iron and Steel Co.'s works (and here he might say that he expected to start a 200-ton furnace at their place in the first week in the new year) ; the Bertrand-Thiel process, at the Earl of Dudley's Round Oak works ; and the direct process, in operation at their Clarence and Britannia works.

It was possible that each of these systems might have advocates present, who would advance the claims of the process which he individually favoured.

In his opinion the direct process was the correct one ; and he thought he was not going beyond the mark in saying that steel makers who wished to "line up," as the Yankees say, would have to adopt it, if they wanted to keep abreast of the times. It was claimed for the Talbot process that it worked very well at Frodingham. His own opinion was that if there was one place in the country where there was a chance to work it successfully it was at Frodingham, because undoubtedly they had the best and most suitable iron to deal with.

Taking into consideration the class of iron they had in the Cleveland district, and from the information he had from Round Oak, he thought the Bertrand-Thiel process was a very good one, and well worth the consideration of anyone who might be seriously thinking of adopting any of the direct processes. Personally, he had had no practical experience of the Talbot, and very little of the Bertrand-Thiel process.

As regards their own direct process at Middlesbrough, he was pleased to say that they were doing very well. At the Britannia works, they had a mixer with a capacity of 350 tons, and at the Clarence works one capable of holding about 250 tons. Both worked by producer gas.

The question might be asked, "Why a mixer ?" Well, in his mind, it was everything ; because they could then guarantee an almost uniform class of metal to the melting furnaces, and they were also in a position to "doctor" it in the mixer if they happened to be getting a "run" of inferior metal from the blast furnaces.

The metal came from the blast furnace in 15-ton ladles, and was poured into the mixer. Oxide of iron and limestone were charged into the mixer to reduce the silicon in the metal to about ·8 per cent., and they could also deal partly with the sulphur.

At the Clarence works the metal from the mixer was then poured into 25-ton ladles and taken to the steel furnaces, where the ladle was lifted on a hydraulic lift and the metal poured down the spout into the furnace, which had been previously charged with ore and limestone sufficient to remove most of the silicon, carbon and phosphorus. At the Britannia works the only difference was that they brought the metal from the mixer with the

75-ton overhead electric crane, which they also used in the casting pit.

The metal as it came from the mixer contained about ·8 per cent. of silicon, and on an average about ·15 of sulphur.

British Pig Iron and Bessemer Steel in 1903.

The British Iron Trade Association has ascertained that the production of pig iron in the United Kingdom during the first half of 1903 was 4,378,998 tons, which is an increase of 282,520 on the make for the corresponding period of 1902, and is at the rate of 8,757,996 tons for the 12 months. In Scotland, Durham, and the North Riding of Yorkshire—the Cleveland district—there is a material increase on the output of the corresponding half of the previous year. In South Wales and in West Cumberland there has been a decrease, and in Lancashire, South Staffordshire, Derbyshire, Northamptonshire, South and West Yorkshire, Shropshire and North Wales, there has been an advance.

Statistics which have been included by the association from manufacturers show that the output of Bessemer steel ingots in the United Kingdom in the first half of 1903, amounted to 911,670 tons, which compares with 888,378 tons in the corresponding six months of 1902. The most notable changes, as between the two periods, have been an increase of 35,784 tons in South Wales, and of 3,937 tons in the Cleveland district, a decrease of 25,823 tons in the Sheffield district, and an increase of 12,548 tons in Staffordshire, Shropshire, etc.

The aggregate production of pig iron throughout the world last year is estimated at 44,557,991 tons, as compared with 40,889,358 tons in 1901, showing an increase of 3,668,633 tons. The United States contributed 18,003,448 tons, as compared with 16,132,408 tons in 1901—an increase of 1,871,040 tons.

The First Blast Furnace in South Africa.

The *African World* announces the erection of the first blast furnace in Africa. It is expected to be blown in about February next. The discovery of workable iron ore in the Lydenburg district of the Transvaal has lately been eclipsed by the location of rich iron ore deposits within a radius of a dozen miles from Pretoria. A furnace, which will have a capacity of 500 tons of pig iron weekly, is now being constructed, and in addition there is to be a complete installation of rolling mills for the production of rails and merchant sections, and black sheets for galvanising, etc. A steel-converting plant has also been arranged for. It is estimated that about 62,000,000 tons of iron are actually in sight.

Engineering Standard Committee Tests.

The third report issued by the Engineering Standards Committee is by Professor W. C. Unwin, and deals with the Influence of Gauge Length and Section of Test Bar on the Percentage of Elongation.

The report deals with the variation of percentage of elongation with different gauge lengths and sections of test bar. It is based almost entirely on tests of steel plate test bars supplied by Mr. Colville, of the Dalzell Steel Works, Motherwell, N.B., and by Mr. Dick, of the Parkgate Steel Works. These tests cover a wide range of conditions, and no such complete information as to variation of elongation with the form of test bar has been previously available.

High-speed Tool Steels.

In a paper on high-speed tool steels, contributed by Mr. G. Borcherding to the Mechanical Engineers' Association of the Witwatersrand, it was remarked that the production of the modern high-speed steels with their wonderful capabilities was the outcome of numerous experiments and assiduous labour on the part of Sheffield's best men—a grand testimony that the old town kept apace with the times, and meant to maintain the first place amongst the steel centres of the world.

Doubtless, most of the gentlemen present would already have considered the question that in the near future it would be absolutely necessary to increase the shop engine power to meet the requirements of high-speed cutting tools.

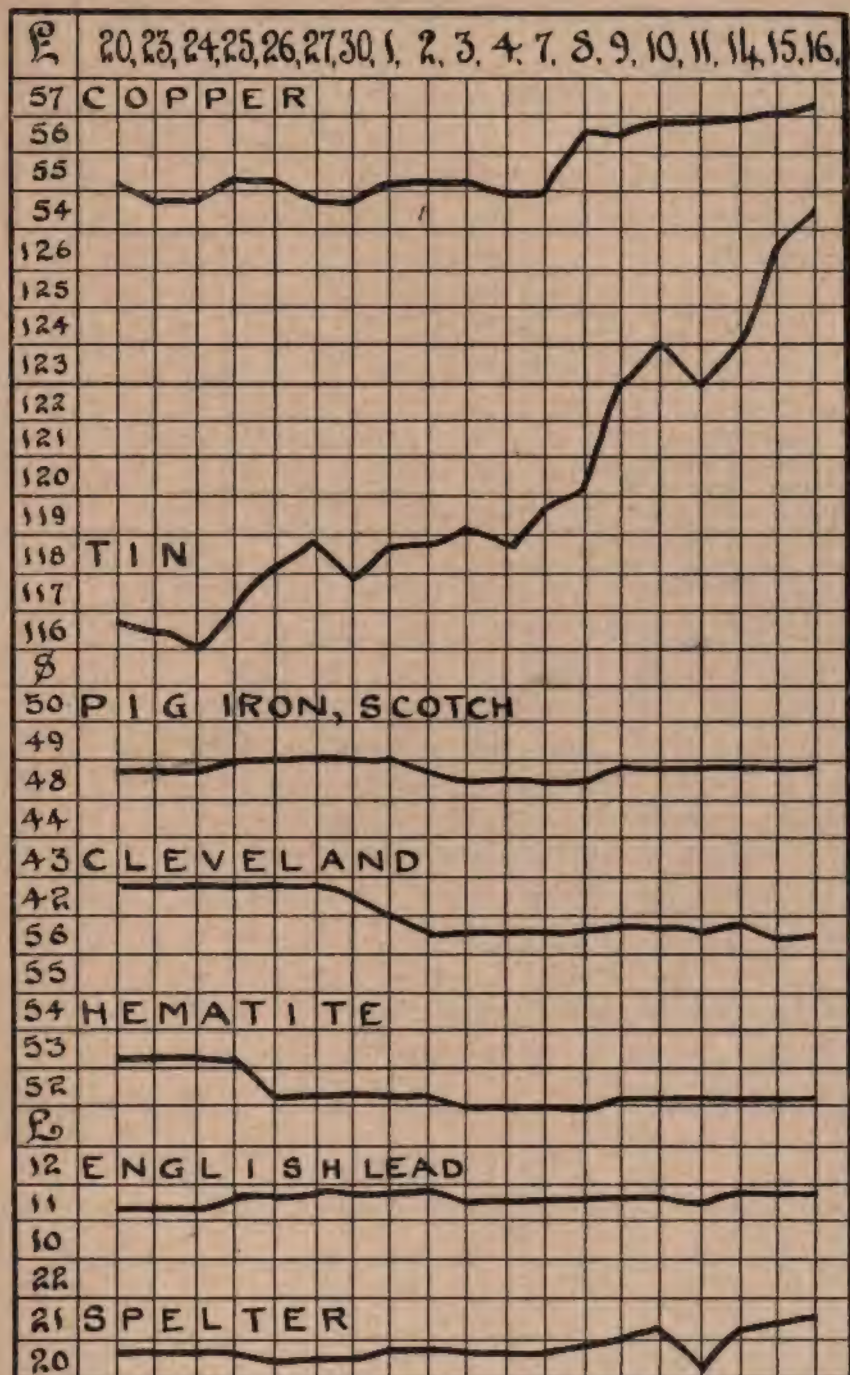
In fact, machine tool makers in England had fully grasped the situation, and in their catalogues already could be seen lathes with what appeared at first sight an abnormally large belt pull, and where the electric motor was embodied in the designs motors of a power apparently out of all proportion were fitted. Lathes of 12 in. centres, fitted with 6 h.p. motors, would, he thought, become quite common.

The general effect of these high-speed steels in the immediate future would be towards a revolution in the design of machines and machine tools; not only must the driving power be increased, but the saddle and slide-rests must be stiffened and the feed be gear-driven. Where the usual practice of $\frac{1}{32}$ in. and $\frac{1}{16}$ in. feeds now prevailed there would be $\frac{1}{8}$ in. and $\frac{3}{16}$ in. feeds.

According to statements made from various sides, the use of high-speed steels had already made it possible to decrease the cost of machine building from 25 to 33 per cent. At the same time, with the demand for machines that would give a cutting speed of at least 100 ft. per minute with a greater rate of feed, there was going to be plenty of work for draughtsmen and pattern makers, and an unlimited supply of firewood for the cupola until many of the patterns cherished at present were replaced.

The State Iron Foundry of Japan.

The *Financial and Economical Annual of Japan* gives some details of the expenditure for 1903-4 upon the State Iron Foundry. Since the establishment of the foundry a sum of about 15,000,000 yen (£150,000) has been disbursed, and the foundry has commenced the manufacture of rails on a pretty large scale. The enterprises, however, are not completed as yet, and in view of the probable great increase in the demand for iron, along with the extension of railways and the naval expansion, it has been decided to spend a further sum of 905,000 yen (£95,000) on the foundry in the current financial year.



THE HOME METAL MARKET.

Chart showing daily fluctuations between November 20th and December 16th.

POWER STATION NOTES.

The Genesis of the Large Gas Engine.

When Cockerill, Korting, Crossley, Orchelhäuser, etc., showed that it was possible to build gas engines of 500 and 1,000 h.p. and over, those who had so often said that gas engines of over 200 h.p. could not be made to run satisfactorily suddenly collapsed. The writer always had an open mind on the subject, but he must confess to being startled when, on the opening day of the Paris Exhibition of 1900, he stumbled against a giant machine, and was told by one of Cockerill's workmen that it was a *moteur à gaz*. Since then the large slow-running power-gas engine has become widely adopted for blowing purposes and for electric driving of iron and steel works it has also made great headway on the Continent. In England, where the idea of using power-gas originated, we seem to do little else but *talk* about it. What in the world are our iron and steel manufacturers waiting for?

Gas Engines Driving Alternators in Parallel.

One point which was somewhat uncertain in regard to large slow-running gas engines was, whether they could be depended on to drive alternators in parallel.

This has at last been answered in the affirmative at the Ilseder Iron Works, Germany. In this installation there are two 500 h.p. gas-driven blowing engines which take the place of the original steam blowers, and use only one-fifth of the gas necessary when generating steam. The bulk of the gas is thus available for electric power purposes, and six 1,200 h.p. three-phase generating units are being installed. The engines are of the Orchelhäuser type, having two pistons working in one cylinder and moving in opposite directions at the same time. A pump driven from the piston-rod forces air and gas at a few pounds pressure into the cylinder, and compression takes place when the pistons approach each other. Regulation is effected by the mixture of gas and air, so there is no missing of explosions.

The three-phase generator gives 10,000 volts, and the revolving mass has a flywheel effect of 2,500 foot tons, the irregularity factor at full load being $\frac{1}{350}$. There are two engines to each three-phase generator and the crank shaft is so arranged that either engine can be uncoupled for examination or repair.

Steam driven three-phase units are also in use, and it is found that the gas driven unit and the steam unit run perfectly in parallel even when one half of the gas engine unit is laid off. The gas engine governors are electrically controlled from the main switchboard and there is no trouble in synchronising. It may be mentioned as an additional interesting fact connected with this plant that the steel-rolling mills which are four miles away are entirely driven by three-phase electric motors.

Synchronising Cranks.

When C. E. L. Brown equipped the Central Station of the Frankfort Municipality he installed single crank slow-speed engines, and to ensure them running in parallel, introduced an ingenious device for synchronising the engine cranks.

This is effected by an electric bell and a contact on the flywheels; the method naturally requires that all the engines should run at the same speed, and that this has been kept in mind when ordering extension sets.

So far as the writer is aware, Manchester is the only station in this country where the engine cranks are synchronised. The six units laid down under the Kennedy scheme are all the same size and speed, but the two units ordered by the late city engineer are much larger, and run at a different speed. It will be interesting, therefore, to see how the synchronising works out when these new units are ready.

Costs and Tariffs of Water Power Electric Stations.

In a recent book, by Martin, entitled "Les Distributions d'Energie Electrique," there are some interesting figures on the costs of water-power electric stations. The large water-power station at Vizzola, in Northern Italy, for example, has a capacity of 22,000 h.p., and the capital expenditure has been £1,600,000, or, say, £72 a horse-power. The Société de Gouage à Lyon water-power station has a capacity of 27,000 h.p., and the capital expenditure has been £1,600,000, or £59 a horse-power. This latter company sells its energy at the rate of £4·8 to £14 per horse-power per annum. In the silk-weaving district of St. Etienne, in France, energy is sold at from £12 to £24 per horse-power per annum. In Switzerland the following are the tariffs for energy supplied from a water-power electric station: For motors using $\frac{1}{10}$ to 1 h.p. £12 to £10 per horse-power per annum; for motors using 30 to 50 h.p. £8 to £6 per horse-power per annum; for motors using 50 to 100 h.p. £6 to £4 8 per horse-power per annum.

Cooling Large Step-up and Step-down Transformers.

For large step-up and step-down transformers used on power circuits the question of cooling assumes considerable importance. There are two principal ways in which it may be effected—one is by air-blast and the other by oil circulation.

With air cooling the blower requires about 1 h.p. for each 200 kilowatts of transformer capacity, the air pressure per square inch being about $\frac{3}{4}$ oz. to $\frac{1}{2}$ oz. It is important that the temperature of the transformer must not be lower than that of the surrounding air, or condensation of moisture may take place.

With oil cooling it is important to take great care to have an absolutely neutral oil without any moisture in it whilst the insulation also must be selected for working in oil. The water coils for keeping the oil cool require about one gallon per minute for 500 kilowatts of transformer plant. 1,000 kilowatts would require about half as much again.

Ornate Chimneys.

As a rule the British public are long suffering in artistic matters, and yet at times there is a growl. Thus, not so long ago, there was an outcry about the ugliness of street hoardings, and as a result we have now those beautiful posters by Aldin, May, and others. Chimneys are monstrously inartistic, and yet they are capable of being made really beautiful, fit to look upon, and at the same time useful as a means of viewing the surroundings. In Dresden, for example, the electric lighting and heating station is situated close by the Palace, opera-house and art gallery, and therefore a chimney of the ordinary type would have been wicked. The various authorities considered the matter with the result that the power-station chimney is so disguised as to be a really artistic feature of one of the finest views of Europe. Of course, this is a special case, but the writer commends the idea to authorities of cathedral cities and watering places, etc., where an ordinary chimney-stack would offend the eye.

Taking them as a body, electrical engineers are artistically reasonable and would not require much pressing. They are responsible for the overhead trolley-wires, it is true, but, after all this is nothing compared with the horrible gas works and gasometers with which our friends the gas people pollute the atmosphere and spoil our view.

Vertical *v.* Horizontal Water-tube Boilers.

The chief requirement in a water-tube boiler is that the sedimentary matter shall be got rid of, or deposited before coming in contact with the portion of the boiler exposed to the hottest gases. This calls for good water and a large mud-drum, a great fault in water-tube boilers being that the mud-drum is far too small. Rapid circulation is a *sine qua non* for all water-tube boilers, and in this respect the vertical tube of the Stirling type, where each tube has full outlet into the drum, would appear to be better than the horizontal type where a number of tubes enter a single header having restricted outlet. The vertical tubes also allow steam to get away quicker, and they are not so liable to have smoke dust deposited on them, as is the case with the horizontal tube. Another very important requirement is that all parts should be circular or spherical, so as to admit of free expansion without straining. There should be no cast metal, and in this respect headers are certainly at a disadvantage.

One point in connection with water-tube boilers is that the direction of the circulation must never change. Now it is a well-known fact that in the horizontal water-tube type this does sometimes occur if hard pressed, and it results in the bottom row of tubes blistering by the pocketing of steam. As a result steam in large quantities is forced up the rear header, resulting in violent upheavals or geyser action in the steam and water drums, and heavy priming. Baffle plates are fitted over the discharge from the rear headers to try and obviate this trouble as much as possible.

In the vertical type the steam enters the rear bank of tubes where the heat of the furnace gases is lowest, and should any salts or other sedimentary matter be deposited the heat there is not sufficient to create a hard scale. The front bank of tubes, where 70 per cent. of the total evaporation takes place, thus escapes any scaling, and as each tube has a discharging outlet of its full area no pocketing of the steam can take place however hard pressed.

Flywheel Design.

The flywheels of slow-running engines are imposing, and have to be designed very carefully to meet the conditions of fluctuating loads, whilst at the same time not exceeding the safe limit. Accidents are happily much rarer than they were, and this is, no doubt, due to the greater skill which is given to the design of the flywheel, and also to the fact that most slow-running engines nowadays are fitted with an automatic stop motion.

In a cast-iron flywheel rim the safe tensile working stress is reached, at a maximum peripheral velocity of 100 ft. per second, which corresponds to about 80 ft. to 90 ft. per second on the mean circumference; the maximum stress due to centrifugal force being then about 1,000 lb. per square inch. If the rim is solid this means a factor of safety of twelve, or if link-jointed a factor of safety of eight, which is about the minimum. Flange-jointed wheels should not be run above 70 ft. to 75 ft. per second, whilst built-up steel wheels may be run at 130 ft. per second.

A good average value for the energy necessary to be stored in flywheels for electric lighting purposes is 2·9 foot-tons per electrical horsepower or for traction purposes 4 foot-tons. For a 500-kilowatt set with two-crank engine, the rotating mass will weigh about 50 tons, for 1,000-kilowatt about 60 tons, for 1,500-kilowatt about 75 tons, for 2,000-kilowatt about 100 tons and for 2,500-kilowatt about 150 tons.

Speed Variation in Flywheels.

An important factor in designing flywheels for lighting or traction purposes is the value to be given to the co-efficient of speed variation allowable between the maximum and minimum limits. For ordinary lighting loads with continuous current dynamos the co-efficient is from $\frac{1}{100}$ to $\frac{1}{200}$. For alternators working in parallel on lighting loads $\frac{1}{250}$ to $\frac{1}{300}$, and for traction $\frac{1}{300}$ to $\frac{1}{400}$. Of course every maker has his own ideas on the subject, thus Messrs. Sulzer Bros. say $\frac{1}{250}$ for lighting and only $\frac{1}{150}$ for traction. This co-efficient is sometimes expressed as a certain number of electrical degrees of variation per impulse, thus a common value is 6 deg.—that is 3 deg. increase or lag from the mean. In an alternator with 60 poles driven by a two-crank compound engine, each pair of poles will describe 360 deg. in one cycle, so that the total number of electrical degrees described is $\frac{60 \times 360}{2}$. At the same time the number of impulses per revolution is four, so that the number of degrees described in one impulse is $\frac{60 \times 360}{2 \times 4} = 2{,}700$. The co-efficient will now be represented by $\frac{6^\circ}{2{,}700}$ or $\frac{1}{450}$, which is about right for good American practice.

Any one wishing to investigate this matter further cannot do better than consult a paper by Mr. Marshall Dourier in the Proceedings of the Institute of Engineers and Shipbuilders of Scotland.

The Unreasonableness of Governor Requirements.

It would be a good thing if some one thoroughly conversant with governors and their little peculiarities would go round and talk sense to some of the various consulting engineers. For by process of paraphrasing each other's specifications, and going one better each time, governor requirements have reached a point practically unattainable.

To attempt too much in governing is worse than to do nothing at all, because the finer the governing, or in other words the nearer one goes to the hunting point, the more likelihood of a serious accident. One frequently sees specifications calling for a control of speed within *one per cent.* of the normal from half load to full load, and when the full load is suddenly thrown off the increase is not to exceed 4 *per cent.* At the same time there must be provision for altering the speed up to 10 *per cent.* either above or below the normal whilst the engine is running. Even if it were possible to keep within one per cent. at any time the last requirement of a 20 per cent. variation of speed entirely gives the show away; it is a moral impossibility to have both. If the engines are driving alternators the points to be aimed at are, first to get them synchronised, then when in parallel to keep them in, and finally to see that each engine does its fair share of the work. Experience shows that an engine governing within 5 per cent. is more likely to attain these results than one governing within one per cent.

AMERICAN RÉSUMÉ.

NEW YORK, December 19th, 1903.

Modern Steam Yachts.

At the annual meeting of the Society of Naval Architects and Marine Engineers, held at New York, a paper was read by Mr. C. H. Crane of this city, entitled "Some Thoughts on the Design of Modern Steam Yachts." It was remarked that the American steam yacht had developed from the English designs, which from the first were sea-going ships rather than harbour boats. On this side of the water greater engine power (for higher speed) and more luxurious fitting were demanded, and the problem had been to meet these requirements without making the vessel less roomy or less sea-worthy than the English boats. Steam yachts were either ferryboats, to take the owner to and from his country place, or cruising vessels for making long tours. The development in steam-yacht building had been great in recent years. As many as 253 American-owned steam yachts, of 28,306 tons aggregate, had been built since 1890; this was over half the number at present registered in America. The plans of one of the most recent, the *Noma*, were given in the paper to illustrate how the requirements for comfort, speed and sea-worthiness had been met in a particular case. The vessel was 226 ft. on water line, 28½ ft. in breadth, and 18½ ft. deep, with a trial displacement of 1,035 tons and a speed of 19 knots. The engine was a four-cylinder, triple-expansion engine, running at 205 revolutions per minute of 4,200 i.h.p. Almy water-tube boilers were used. The vessel had large bilge keels "which apparently did not interfere with her speed." It was stated that 22 per cent. of the displacement, exclusive of coal, water and stores, was occupied by machinery, while 37½ per cent. was given up to outfit and joiner work.

American Society of Mechanical Engineers.

The most important business of the year, mentioned in the annual report of the Council of the American Society of Mechanical Engineers, was connected with the munificent purpose of Mr. Andrew Carnegie, who is a member of the Society, to give the sum necessary to make adequate provision for the accommodation of the four national societies of engineers, in an appropriate building, and for the Engineers' Club in another. Mr. Carnegie expressed his willingness to make the amount of his gift exceed a minimum of one million dollars, if that sum should be found inadequate to give the accommodation required for the present and the future needs of the organisations which he named. The four constituent societies named by Mr. Carnegie have appointed representatives, and from these representatives an executive committee has been formed, which since the adjournment of the Saratoga meeting has been formulating the details of the arrangement of the building, and another sub-committee has been considering the proper method for the management and control of such a joint undertaking. The report of these committees will be made public in the near future.

A New Type of Four-Valve Stationary Engine.

One of the papers at the New York meeting of the Society dealt with the construction and efficiency of a Fleming Four-valve Engine, directly connected to a 400 kilowatt generator.

Its nominal capacity is 500 h.p. at a speed of 150 revolutions per minute, 150 lb. pressure at the throttle and 26 in. vacuum. The cylinders are so proportioned as to give the high ratio of 1 to 3·13 following the style advocated by Mr. Geo. Rockwood. No steam jackets are used, but a vertical tubular reheating receiver is placed in the steam passage between the two cylinders, steam being admitted to the high pressure cylinder through triple ported valves of the Corliss type working in chilled iron bushings, the governing being accomplished by a centrally balanced inertia shaft or wheel governor. This governor is so constructed that it is practically balanced in all positions, being made with two inertia arms, the centres of gravity of which move in harmony with each other about the centre of rotation, the balancing feature avoiding surging or violent action under all conditions of operation. This operates, by means of bell cranks, the steam admission valves of the high pressure cylinder only, and is so arranged as to decrease the lead at the earliest point of cut-off. The steam valves of the low-pressure cylinder are controlled by a fixed eccentric, so arranged that the cut-off in that cylinder can only be varied when the engine is not running, and remains constant under all conditions of load and pressure. The exhaust valves of both cylinders are of the Corliss type operated by a single eccentric through the medium of a peculiar arrangement of rocker arms and bell cranks. The author, Mr. B. T. Allen, describes a number of tests which he considers have fairly established the following principles:—

(1) That as a prime mover the elaborate dash pot or other accelerated cut-off devices used in present Corliss engine practice are unnecessary complications and unwarranted when comparing results.

(2) That the centrally balanced, direct acting fly-wheel device serves its purpose to better advantage than the indirect fly-ball governor.

(3) That there is better warrant for shorter strokes and moderately high speeds than for longer strokes and resultant lower speeds, notwithstanding the element of clearances.

(4) That self-lubrication without additional apparatus requiring attention to secure it, enters as an improvement in net efficiency, to say nothing regarding maintenance.

(5) That an engine of the described design, although of marked improvement in point of simplicity will rather exceed than equal the more elaborate practice heretofore established at normal load and excels comparable prime movers in a marked degree where the work is of a widely fluctuating character.

(6) That considering a resulting decrease in the cost of foundations, building, floor space, and, in electric practice, generators, due to better speeds, the design described determines its importance from the standpoint of investment.

What are the New Mach'ne Tools to be?

This was the title of a paper contributed to the American Society of Mechanical Engineers by Mr. J. E. Sweet, who said he thought the machine-tool builders would admit that the machines must be re-designed in order to get even a fair share of the ultimate possibilities offered by the new high-speed tool steel. To the most of them would this mean anything but just to make the driving elements more powerful and the machines stronger—which was as much as to say everything had been all right, and all they needed to do was to change the strength and power? But had they been all right or half right? It could be shown by figures, he supposed (he knew it to be a fact by a trial with models), that a complete box was thirteen times more rigid against torsion and four times

more rigid against bending than the same amount of material was in the form of side plates and thin cross girts. It was probably from four to eight times more rigid than the cross-girt plan in any form, and yet in the case of lathes, the whole business of whose beds was to resist torsion, only one or two builders had had the courage or audacity to adopt the box form. Milling machines of the planer type were constructed like planing machines, seemingly without a thought but that the conditions were identical, while they were not. In the course of further remarks he said that to get the best out of machines, they not only wanted to be rigid and true, but the drive must be powerful. While manufacturing was going to call for many more simple machines—that is, machines to do one thing rapidly and well—the machines which would do a variety of work would be still in demand, for the sparsely settled sections of the country and the colonies would call for the country machine shop as of old.

Hints on Shop Construction.

Mr. F. A. Scheffler presented an ideal scheme for laying out new shops, covering a complete equipment for manufacturing on a large scale. The plan proposed was primarily designed for the manufacture of electrical apparatus, but the author remarked that it would be applicable to any other kind of manufacturing, where it was desired to have a number of shops which were to be easily accessible for business purposes and for the delivery and shipping of material. In the centre of the space available for the buildings the plan provides for an administration building, constituting the business, accounting, and sales offices; and on the second story, the draughting room. This building is octagonal, or hexagonal, whichever may be found to be most suitable for the purpose. In this case, it has been designed with a view of accommodating seven buildings, which radiate from each side of the octagon, and has one side reserved for the main entrance through the building. The end of each shop which is nearest to the administration building has its individual office for the foremen and shop clerks. This, it will be seen, is a very harmonious arrangement, as every shop is then but a short distance from the administration building, so that intercourse can easily be had between the drawing-room, offices and the offices of each shop. The general arrangement gives each shop plenty of yard room, which is also very essential; and travelling cranes, either worked by hand or power, could be located in the yard room between any two of the shops, for handling raw or finished material. A circular track around the administration building connected in front of each shop building by means of suitable turn tables, worked by hand or power, makes the distribution of material between the buildings very easy, and the distance the material will have to travel from any one building to another is comparatively short. At the extreme outer end of each building is another circular track, primarily to be used for shipping purposes, and the distributing of such material as may come in or go out over the connecting railroad lines. This track runs through the end of each building; and in such buildings where the machinery, castings, or other goods are to be handled, the heavier travelling crane in that particular building which should run the length of the shop, can easily unload or load the cars. This arrangement makes it possible to go into every shop without having a multiplicity of tracks and switches, thus cutting up the available yard room, as is usually the case in ordinary plants. It is also possible, if there is sufficient ground available, to extend any one or all of the buildings, and still retain the best features of the design.

The New Steam Turbine Station at Newport, R.I.

The first vertical Curtis steam turbine installed in America is a 500 kilowatt machine at Newport, R.I.

The Newport station is one of several controlled by the Massachusetts Electric Companies, who operate about 900 miles of electric street railways and have already contracted for 33,000 h.p. in steam turbines. Three of these are 500 kilowatt machines, and will be installed at Newport, while the others will be placed in stations at Fall River and Quincy Point, Mass., and will be much larger units.

The Newport turbine, at present in operation, runs at 1,800 revolutions per minute, taking steam at 140 pounds pressure at the turbine nozzles. Alternating current of 2,300 volts is generated. The turbine is 7 ft. 8 in. in diameter at the base, and 12 ft. 6 in. high. The station plans call for four turbines in all.

Automatic Machine for Track Laying.

Mechanical improvements have made it possible to construct railroads in the United States with a speed that would have seemed impossible a decade ago. An instance of the development in this direction is given in a recent issue of the Cincinnati *Enquirer*, which describes a peculiar piece of mechanism—that is, laying the tracks of the Cincinnati, Richmond and Muncie railroad at the rate of two and a-half miles a day. This track-laying machine automatically and accurately lifts the ties and rails into position, the most drudging labour in all railroad construction. It also furnishes the motive power for its own construction train.

There were stretches of roadbed over which the construction train moved at a rate of over 1,800 ft. an hour. The machine utilised was one which differs in many essentials from that which has been used in other sections of the country. One of the most interesting features is the manner in which the material is delivered to the roadbed and the comparatively few men required for the different operations, as the ties and rails are lifted and moved from the cars on which they are carried to the roadbed, being connected and spiked while the train is in motion.

An endless chain carrier puts the ties in position, while a crane suspended upon a steel truss lowers the rails in advance of the construction train. In this manner the engineers in charge of the road hope to run into Cincinnati many weeks earlier than they could otherwise have done. The machine weighs fifty tons, and was made in Scranton, Pa., U.S.A. It is the only one of its kind in existence, and its inventor, Mr. Hurley, who accompanies the machine, spent ten years in perfecting it and thousands of dollars on models before success crowned his efforts.

The work done upon the Cincinnati, Richmond and Muncie road demonstrated that a force of about forty competent men were all that were required to operate the machine to its fullest capacity, and that when conditions are favourable over three miles of track a day of ten hours could be put down without difficulty, while an average of over two and one-half miles could be recorded. The gearing on which the material is conveyed from the platform through the machine can be operated at the same rate of speed at which the train is moved or its speed can be doubled. The weight of the rails handled include the heaviest used for American standard-gauge construction.

SOUTH AFRICAN RÉSUMÉ.

Mineral Output of the Transvaal.

The following tables have been compiled from the Official Mining Statistics issued from the Government Mining Engineers' Department, and show the results for the third quarter of 1903.

GOLD.

Month.	Yield in ozs. fine.	Value in £ sterling.
July	252,944	1,074,432
August	273,591	1,162,141
September	276,787	1,175,716
Totals	803,322	3,412,289

SILVER.

Month	Yield in ozs fine.	Value in £ sterling.
July	30,343	3,123
August	33,408	3,493
September	32,668	3,460
Totals	96,500	10,076

COAL.

Month.	Tons.	Value realised at pit.
July	219,660	85,179
August	213,004	82,357
September	204,537	80,026
Totals	637,201	247,562

DIAMONDS.

Month.	Carats.	Value.
July	19,793	23,667
August	13,751	22,766
September	20,329	28,138
Totals	53,873	74,571

A Rand Bore-hole.

Of the numerous bore-holes which have been put down with diamond drills to locate the reefs on the deep level claims of the Witwatersrand one of the most easterly is that recently completed by Messrs. Lewis and Marks on the farm Grootvlei, about thirty miles due east of Johannesburg.

JOHANNESBURG, December 10th, 1903.

The record of the core gives a good idea of the general nature of the strata overlying the reefs.

Surface to 903 ft.	Dolomite.
	Quartzite.
931 ft. to 1415 ft.	Kimberley Series of Reefs.
	Quartzite.
	Slate.
	Quartzite.
	Slate.
	Quartzite.
2084 ft. to 2153 ft.	Bird Reef Series.
2153 ft. to 2373 ft.	Banded Slate.
	Quartzite and Slate.
2616 ft. to 2760 ft.	Amygdaloidal Diabase.
	Quartzite.
2933 ft. to 2949 ft.	Modderfontein Series of Reefs.
2996 ft. to 3414 ft.	Van Ryn Series (now recognised as part of the Main Reef Series) in the following order :—
	Leader 9 inches.
	Leader 4½ ,,
	Leader 3½ ,,
	Reef 21 ,,

The Tinfields.

The discovery of tin in the Transvaal has been followed up during the last few months by prospecting work undertaken by the Transvaal Tin Mines Syndicate with the result that the property has been taken over by one of the leading financial houses with a view to systematic prospecting and subsequent flotation, if the former operation justifies the latter.

Several tin-bearing lodes have been found which it is proposed to prove by means of an adit, driven in approximately at right angles to their strike in order to show whether the lodes continue in depth and also whether it will pay to work them.

The property is situated on a Government farm named Oshoek adjoining the Swazieland border, and as a matter of course a large quantity of ground in the neighbourhood has been acquired or taken under option for prospecting or speculative purposes.

A limited company has been formed to prospect and develop the adjoining farm, Bettysgoed, into which the same tin-bearing lodes are presumed to run.

Natal Harbour Department.

An order has just been given out for the lighting of the Suction Dredgers *Curlew*, *Ibis*, and *Water Rat* by electricity, to enable them to work by night. Tenders were informally called for, and Messrs. Greenwood and Batley, Ltd., of Albion Works, Leeds, through their direct representative at present in Durban, were successful in securing the order.

The plant which will be supplied consists of three complete sets of 7 b.h.p., 4·4 kilowatt, de Laval Patent Turbine Dynamos, arranged to work either condensing or non-condensing, at a steam pressure of 50lb and 110lb per square inch, two being fitted for the latter pressure. The voltage of the dynamos will be 110, and the capacity of the sets is equivalent to about 140 8-candle power incandescent lamps.

The wiring of the dredgers will be done departmentally, under the supervision of Mr. G. Stobie, A.M.I.E.E., the Harbour Electrical Engineer, who has great confidence in the future of the Steam Turbine. The installation will be completed early in 1904.

GERMAN RÉSUMÉ.

BERLIN, December 21st, 1903.

High Speed Trials with Electric and Steam Locomotives.

In the course of the Marienfelde-Zossen high speed trials, the safety of working of the current collectors was particularly remarkable even for the highest speeds. Many runs at 200 and more kilometres per hour were performed by both cars, speeds as high as 208 kilometres being, for instance, reached on November 25th. Special attention has been paid to braking and inertia tests. By increasing the braking pressure, the braking distance has been more and more reduced. Moreover, a new device has been tested, preventing automatically the wheels from being braked at decreasing speeds by drawing air off from the braking cylinders. Trailing experiments have been performed on six-axle sleeping cars, connected to the high-speed cars, it being shown that trailers up to speeds of 160 kilometres will run rather smoothly, material oscillations being observed only at speeds as high as 180 kilometres.

These experiments having shown that existing permanent ways, with careful construction and supervision of the track, are capable of standing much higher speeds than those now in vogue, even without any specially designed cars, the Prussian railway authorities have decided on undertaking on the same Marienfelde-Zossen military railway some further experiments as to the performance and behaviour of several types of locomotives. It is intended to reach speeds as high as about 140–150 kilometres per hour, and as the locomotives ordered for this purpose are now complete, it is anticipated that these experiments will be started in a very short time.

Additions to the Berlin Elevated Railway.

Some further developments of the Berlin "Hochbahn" lines have been under consideration for some time, and according to information just to hand, a provisional prolongation of the Elevated Railway from Potsdamer-Platz to Hausvoigtei-Platz appears to be definitely decided on, the beginning of the work being anticipated for next spring. A further project has been submitted to the superintending authorities in regard to an additional line from the Charlottenburg-Knie station as far as Wilhelms-Platz, Charlottenburg, and it is safe to state that the construction of this line will also be commenced in the course of next year. On the other hand, as regards a contemplated rectilinear prolongation of the Charlottenburg line as far as Westend, a Charlottenburg suburb, negotiations are not yet concluded.

The Siemens and Halske Rapid Type Printing Telegraph.

A novel kind of rapid type-printing telegraph is being developed and has just been brought out by the Siemens and Halske Company. The apparatus belongs to the class of the so-called automatical telegraphs (Pollak-Virag system) where the telegram is prepared by a typewriting device piercing for each letter to be telegraphed a given hole or set of holes in a continuous paper ribbon. The latter on being drawn through the rotating telegraphic transmitter will automatically throw corresponding current impulses into the circuit. As the Siemens apparatus is capable of telegraphing 2,000 letters per minute on the same line, whereas each official even with the best of apparatus cannot transmit any more than 200 to 300 letters in the same interval of time, it will be possible to send the telegrams transmitted by a large number of officials through the same line. In the Siemens apparatus, two holes are pierced in the paper ribbon for each letter, the letter being itself printed in plain printing characters immediately above so that the perforated ribbon contains the telegram in distinctly readable form. Moreover, the public itself will be able to take charge of the perforating, transmitting the prepared ribbons to the telegraph office.

In the receiving apparatus, the ribbon arrives at the same speed ready for sticking on telegram forms, containing the telegram in plain printing.

In order to ensure this printing of 2,000 letters per minute, without any mechanical delicate apparatus, the electric spark is resorted to. A disc where the various letters are cut out as in a pattern is rotated at a speed of 2,000 turns per minute between a spark gap and a continuous ribbon of photographic paper. Whenever a spark passes in the gap, a silhouette of the letter happening to be in front of it is projected on the paper ribbon. It should be noted that the spark must be produced with an accuracy as high as one 40,000th part of a second in order to have the proper letter appear at the proper place. The paper ribbon next passes beneath some sponges impregnated with developing and fixing liquids, the photographic process requiring only nine seconds, so that the ribbon is delivered ready printed.

The problem of causing the spark to be produced with the utmost accuracy at an instant accurately given in accordance with the current impulses transmitted from the sending apparatus, was solved by utilising to a high extent the property of electric condensers of being charged and discharged in very short intervals. The mechanism of the apparatus has hence been so simplified that the receiver, apart from the photographic device, is embodied simply by a shaft driven by an electromotor on which in addition to the above mentioned type disc only some brushes are mounted sliding over contact discs. In addition there are five relays of special design, the tongues of which will follow the rapid impulsions without any difficulty and at a sufficient speed. A special rather ingenious device causes the receiving apparatus to perform in a given time accurately the same number of turns as the transmitter giving off the current.

Experiments for which the Imperial Postal Department had lent some lines have shown the practicability of the apparatus for transmissions over great distances. Dr. Franke, Dr. Thomas and Mr. Ehrhardt have, through their assistance, contributed to the design of the apparatus.

The Berlin Teletyping Central Station.

On October 1st a most valuable addition to the Berlin telephone, with its nearly sixty-eight thousand subscribers, was made, when the "Ferndrucker Centrale" was opened to public service. Telephones, which only render words as they are spoken, are frequently inefficient for business purposes; in addition to a correct transmission of a communication, there will, in many cases, be necessary an acknowledgment in writing of this transmission. On the other hand, there is the liability of telephonic

conversation to be overheard by a third party and finally the person rung up on the telephone may happen to be absent, when his return will have to be waited for and much time be lost. In all these cases, the new teletyper service is intended to afford efficient means of communication.

The teletyper as constructed by the Siemens and Halske Company is a type-printing telegraph, similar to the well-known Hughes type printer and the Baudot telegraph. The main distinctive feature from former apparatus is, however, the fact that the latter moving freely, the synchronism of the instruments established on the same line had to be obtained by the skill of the operator, whereas the operation of the new apparatus being nothing else than a teletypewriter may be learned by anybody in the shortest possible time. The key-board of the teletyper is similar to that of an ordinary typewriter, comprising four superposed rows of seven keys each, out of which twenty-six are each provided both with a letter and a figure or sign of punctuation. As regards the remaining two keys, one serves as beginning or letter key, whereas the other, bearing the inscription "Zahl," is used as figure or punctuation key. By striking either of these keys, the type-wheel of the printing telegraph is adjusted either for letters or figures in a manner similar to the Hughes apparatus. Both of the apparatus connected by a line may be used either as sender or as receiver without any special preparation or switching being necessary, both of them being automatically and simultaneously operated as soon as the first white key is struck, when the apparatus in question becomes a sender, and all is ready for use.

The type-wheel bears on its periphery, in one circle, the letters, and in another parallel circle the figures and signs of punctuation. On acting on the shift key the type-wheel is shifted automatically on its shaft so as to place the row of signs concerned above the printing surface of the paper ribbon. By acting on an ordinary key on the other hand, the type-wheel is rotated as far as to bring the type in question in front of the paper, when the latter is pressed against the wheel and receives the printing, to return downwards again instantaneously and to be moved as far as the interval of two letters, so as to be able to receive the following sign. This process will occur simultaneously in both of the apparatus connected by the line, *i.e.*, both in the transmitter and receiver, being automatic in the latter, no matter whether there is or is not somebody operating the receiving apparatus. In the case of the owner of the apparatus being absent, the telegram may be read on the paper ribbon on his return. The electric printing telegraph will thus give two perfectly similar records of the same telegram, one on the sending and the other on the receiving apparatus.

As soon as the beginning key is pressed downwards, the circuit of the transmitting apparatus is completed, resulting in a switching roller being set rotating, throwing electric currents of alternating directions into the printing telegram circuit and through the line-relays connected to the apparatus; the latter will insert both in the transmitting and receiving apparatus local currents which by means of so-called relay-magnets produce the rotation of the type-wheel from the initial position identical in all the stations. Now, in the case of a letter key being pressed downwards, a peg attached to the other end of its lever will strike against the rotating switching roller brush, stopping the latter and thus the type-wheel of the printing telegraph. At the same time the type levers of both apparatus being attracted will cause the corresponding letter to be printed. As long as the key is pressed downwards, the type-wheels are incapable of moving any further, thus enabling the transmission to take place at any desired speed. After a telegram is transmitted, both the transmitter and receiver will be switched out automatically at a certain position of the type-wheel, the apparatus thus being stopped automatically. Twelve accumulator cells built into a box serve as working battery. The tension of about twelve volts as obtaining in the line circuit is so low as to exclude any possibility of an inductive influence of printing telegraph circuits on neighbouring telephone circuits.

The advantages afforded by the printing telegraph as compared with telephone and present telegraph systems will be evident. Like the telephone, the printing telegraph may serve for a direct communication between two persons over any distances, but for the additional advantage of any hearing-mistakes or other misunderstandings being excluded by the double and simultaneous reproduction of the communication in printing. As above stated, the printing telegraph will, at the same time, make it impossible for a third person to overhear communications which is even possible in the case of the Morse telegraph. This is, therefore, the only means of communication enabling despatches to be kept strictly private.

The central station just opened is fitted with a switch-board having indicators and catches for one hundred subscribers. Sixteen connecting strings allow of thirty-two subscribers being simultaneously connected, so as to enable a simultaneous communication between a third of all the subscribers in the case of the switch-board being complete. As soon as a subscriber presses down the calling key of his teletyper the official in charge of the indicator board of the central station will be advised by the indicator board of the subscriber in question dropping and an alarm being rung, when he will put himself in communication with the caller, in order to ask for the desired connection, and connect both subscribers so that their apparatus are ready for direct communication. This shows then similarity of service with telephone service and the great advantage of any two subscribers communicating directly. There is, however, in addition the possibility of connecting any desired number of subscribers to the same printing telegraph so as to transmit the same communication simultaneously to all the subscribers.

Similar telegraphic services from one central station to a certain number of subscribers simultaneously by a so-called "ticker" have for some time been in use in New York, London and Paris. A similar service has been in operation also in Bremerhaven, Germany, for transmitting ship telegrams from one central station to one hundred subscribers in different places. The central station just opened in Berlin is also intended in addition to the mutual communication between the subscribers, to transmit similar informations to a certain number of subscribers, limiting the service at first to Exchange telegrams. The same system of communication could be employed for transmitting telegrams from a central telegraph office such as Reuter's to a certain number of newspaper offices. In addition, the above central station is intended to secure communication with the central telegraph office for transmitting or receiving telegrams through the State telegraph. The new system has been in use for some time with great industrial concerns, such as the Berlin Allgemeine Elektricitäts-Gesellschaft, and the Siemens and Halske for communication between their various departments.

MINING NOTES.

The Efficient Crushing of Gold Ore.

A very complete paper presented by Mr. R. A. Kinzie to the American Institute of Mining Engineers describes the Treadwell Mines of Douglas Island, Alaska.

The features that have made the Treadwell Mine justly famous are the mining and milling at a profit of ore that does not yield an average of more than 2 dols. per ton.

The crushers are located in the head-frames of the various mines, and are of the gyratory type. When the ore is hoisted out of the mine it is spilled by self-dumping skips on a grizzly formed by 1-in. by 10-ft. pieces of iron, bolted together by 1-in. iron bars, and placed 2-in. apart by disc-shaped pieces of cast iron. The over-size from the grizzles goes direct to the crushers, and the under-size passes through and falls into the ore-bins situated directly beneath the crushers.

Too much stress, says Mr. Kinzie, cannot be laid upon the great effect of efficient crushing as related to the duty and output of a stamp-mill. This is particularly true on the island, where the crushing capacity is in excess of the demand and where there is abundant water-power which costs practically nothing. During the past year the duty of the mills has been increased over 1 ton per stamp in 24 hours, and without a doubt, 50 per cent of this increase has been caused by setting the crushers to break the rock 20 per cent. smaller than before. An efficient crushing-plant for mines similar to the Treadwell would consist of four Gates-crushers arranged in pairs, one above the other, the upper to be of such a size that they would receive rocks 18 by 36 in., and the lower to turn out a product not larger than 1·5 in. in diameter. The rock when hoisted would be dumped on grizzlies with 5-in. spacing bars between : the over-size going to the upper crushers and the undersize falling on a second grizzly with bars set 1·5 in. apart—over-size going to the lower pair of crushers and under-size passing into the storage-bins. The product from the upper pair of coarse crushers to be spilled on the grizzly with bars 1·5 in. apart, the over-size going to the lower crusher and the under-size and crushed product from the lower crushers falling into the bin. If the above method were used it would do away with a great deal of the bull-dozing and rock-breaking in the mines, making a very appreciable reduction in the cost of mining.

Machine Drilling at its Best.

Considerably over 75 per cent. of the ore mined from the Treadwell has come from the open or surface pits. Machine-drilling is seen at its best in these pits. The 3¼-in diameter Ingersoll-Sergeant drills, set on tripods, are used in all the pits at present. The average number of feet drilled per machine in 10 hours is 30·35. The holes are drilled to an average depth of 12 ft., and each machine will break 60-69 tons of ore per shift of 10 hours. When the pits were smaller, and the difficulty of setting up was not so great as at present, the average number of feet drilled was much higher, and the breaking capacity of a machine-drill was from 150 to 200 tons of ore per shift of 10 hours. The pits are worked by drilling and blasting the ore from a series of benches or terraces around the chute-raise as a centre, and when the ore is blasted the broken rock rolls down to the bottom. The small pieces are then broken by sledges, and the larger ones by placing sticks of powder on the surface of the rock, tamping with a little fine dirt, and blasting. For blasting holes, No. 2, or 40 per cent., dynamite is used, while for "bull-dozing" No. 1, or 70 per cent., is the best.

When the rock has been broken to the required size, it is drawn off, through the raises and chutes described above, into cars. These cars are hauled to the station ore-bins by horses, or by endless-rope haulage, where they are dumped. The ore is then loaded into skips, hoisted to the surface, and handled in the usual manner.

Transvaal Coal.

Returns issued by the Mines Department show that during the last three months a check has been given to the output of coal in the Transvaal, and that the output of the year will fall short of expectations formed about three months ago. The principal cause of this shortage appears to be the lessened consumption on the railways.

Chinese Copper and Antimony.

A correspondent of the *Engineering and Mining Journal* points out that China may in a few years be in a position to ship enormous quantities of copper at less than half its present cost of production. China, independent of hundreds of miles of railways now in operation, in course of construction, and provided for, is covered by a complete network of rivers and canals, with a system perfected by centuries of use. The question of transportation would probably never act as a bar to the workings of any property. Labour is to be had in unlimited quantities, good and steady, at rates per month less than are usually paid per day in other countries. Coal of good quality is there in enormous quantities, with other requirements for mining and smelting, such as food supplies cheaper than in any other place where mining is now conducted. Within five years the working of a few antimony mines in the province of Hunan was commenced under Government control, and were it not for this control, the offerings from China would swamp the market ; as it is, prices of refined antimony have been forced down over one-third and Chinese antimony ores are offered of good quality at low prices. The mines are worked by hand labour, with crude tools, and no machinery is used. The ores as brought to the surface, are sorted by women and children and are broken, where necessary into small pieces, hand-culled and dressed. In this way the ore for export and for sale is practically pure. The rejected ores are smelted into crude antimony by a primitive method, with great waste.

OPENINGS FOR TRADE ABROAD.

BRITISH INDIA.

ATTENTION is called to the fact that of late years small screw-cutting lathes have become very popular among Indian craftsmen, who seem only to learn the use of the slide rest, and never that of the hand rest. The screwing tackle of the English country blacksmith of 30 years ago would perfectly suit the ideas of the Indian workman.

ORANGE RIVER COLONY.

It is reported that there is every prospect of small flour-milling plants being sold in the outlying districts out of reach of the large mills. There is no import duty on machinery.

GERMANY.

It is announced that work is soon to be begun upon a steam railway line between Adorf, Saxony, and Rossbach, Bohemia.

SPAIN.

Two prizes are offered for a complete plan and estimate for establishing a water supply for the town of Ferrol. The plan must be sent in within seven months to the Secretariat of the "Ayuntamiento" of Ferrol. The first prize is to be at the rate of about £24 per kilometre to be covered by the water-pipes from the place of supply to the town boundary, and the second prize is to be about £119.

Tenders are called for the public lighting of the town of Rivera for twenty years by electricity. The competition will turn on the annual amount the contractor is willing to accept, the upset rate being 2,846 pesetas, or or £77, for 200 lights.

A concession for 99 years without any subvention from the Government has been granted to the Minera del Moncayo Company for a narrow-gauge railway from Castejon to Olvega.

Tenders, which are to be presented up to 5 p.m. on January 8th, are in demand for the work of the bridge over the River Carts, on the high road from Bailen to Malaga, in the province of Granada, at the upset price of 79,382·79 pesetas, or about £2,398. A provisional deposit of 4,000 pesetas, or about £118, is required to qualify any tender.

Tenders are required in Madrid for the execution of the works of the bridge over the River Tuerto and the crossing of La Baneza, on the high road from Rio Negro to that from Leon to Caboalles, in the province of Leon, at the price of 237,805·88 pesetas, or about £6,954. Last day for upset receiving tender, 15th January.

RUSSIA.

The following railways will be constructed by the State in 1904:—Kherson-Nicolaeff, with a station in the town of Nicolaeff; and Grodno-Zelvtany. In 1905 a line from Novo-Sénaki on the Trans-Caucasian railway to Soukhoum. Plans are to be drawn up for the laying down of a railway to connect Petrozavodsk with the Mourman coast *viâ* Kemi. Velten and Guillaume Company have been asked to estimate for the laying of a telegraph cable, 82 versts long, across Lake Baikal. The depth of the lake is said to vary between 600 and 900 sagenes. The cable would be similar to the Atlantic cables. A despatch has been received at the Board of Trade, pointing out that there will be an opening on a large scale for refrigerating plant, cooling apparatus, and ice-making machinery in the slaughter-houses which it is proposed to erect at Warsaw. Another despatch reports that the Russian Government has decided to construct an electric railway between Sevastopol and Yalta, to pass *viâ* Balaclava, Baidar, Aloupka, and Livadia.

CUBA.

Inquiries have been made through the Board of Trade for the names of manufacturers in this country of machinery for extracting the fibre of the henequen or of other textile plants, like sisal, ramie, etc., in their raw condition, as well as for the manufacturing of mats, hammocks, bags, etc., of the same fibres.

ARGENTINA.

The Congress will deal with the revised project in regard to the construction of a dry dock at San Juan, and the construction of a railway from Rosario to Puerto Militar.

NOTABLE BRITISH PAPERS.

A Monthly Review of the leading Papers read before the various Engineering and Technical Institutions of Great Britain.

SCREW PROPULSION FOR WARSHIPS.

IN the course of an important paper on Screw Propulsion for Warships, read before the Royal United Service Institution, Fleet-Engineer G. Quick, R.N. (retired), remarked that :—

Forty years of practical experience, and thirty years of model experiments had failed to produce any substantial improvements in ships' propellers; but nevertheless, within the last few months we have had the speed of the *Drake* and *Hyacinth* increased by one knot, and the speed of the "County" class increased to 23·7 knots, which would have been impossible if the generally accepted theories of ship resistance at high speeds had been correct. Great as this increase in maximum speed has been, I am convinced that a further series of experiments will prove that even still greater maximum speeds can be obtained from all our modern ships by the simple and inexpensive plan of fitting them with new screws. The cost of such trials and of fitting new propellers would be infinitely small compared with the great advantages to be gained both in maximum speed and in economy of fuel.

The enormous value of the Admiralty improvement of the *Drake's* screw must be apparent to all. But this improvement having been effected, the question arises: Is it possible to make a further improvement in the propellers of those ships so as to drive them at still higher speeds with the same horse-power? Experiments alone on one of these vessels can show exactly how much the maximum speed of those ships can be increased, but I venture to say that by some considerable changes in the present form of the screw propellers there is every probability of an increase of speed of at least one knot being attained with the same maximum horse-power—or, in other words, that the speed of the *Drake* class can be increased to twenty-five knots with the present boilers and engines, and with practically the same coal consumption as at present. To effect this, the proposed new screws would have to be more efficient than the large screws of the *Drake* to the extent of 4,800 i.h.p. And as the large screws of the *Drake* gave a speed equivalent to an increase of 10,500 i.h.p. over the original small screws, I do not consider that twenty-five knots is an extravagant estimate for the speed of the *Drake* with propellers still further improved in design.

Incidentally the author said he did not admit that the tank experiments which are being made in this country and abroad have the same value as experiments made on full-sized ships in deep water. Tank experiments on models indicate the direction in which investigations should be made, but they are not to be relied on in all cases for the formation of hard and fast rules for the design of all classes of propellers. The most valuable contribution which has been made of late years to the solution of the resistance of ships is the discovery of the influence of the depth of water on the resistance and speed of ships.

In the course of further remarks the author said: I do not claim that any definite laws can be deduced from my model experiments on the reduction of the resistance to rotation of blade surfaces, curved and receding, such as I propose, but so far as my experiments and speculative investigations go, they show that *by reducing the width of the blades very considerably near the boss, and by curving and receding the blade surface as described*, the resistance to rotation may be so diminished that from thirty to fifty per cent. less power will have to be expended on rotation only and that the power so saved from reduced resistance to rotation may be expended :—

1. In giving a higher number of revolutions to the curved bladed screw of pitch, diameter, and area, equal to the ordinary screw with radial blades, and a higher speed of hull; or,

2. That the screw with the curved receding blades, if of the same diameter and pitch, may have the width of the end of the blades very much increased without the revolutions of the engines and the maximum power of the engines being increased or reduced thereby, *and that such increased area at the end of the blades, and reduction of width near the boss would lead to a considerable increase in the maximum speed of the ship and large reduction in the number of revolutions required per minute to obtain any required speed*; or

3. For very long ships of fine lines these curved receding blades, with wide ends, may have the same diameter and total area as ordinary blades, but a higher pitch-ratio in order to obtain high speed of hull with a moderate number of revolutions per minute. If in this case it were found that insufficient revolutions, i.h.p., and speed were attained, the question whether the pitch ought to be reduced, or the blades reduced in diameter, must be ascertained from calculations made on the results obtained by that particular ship and propeller.

The total changes in screw propeller design I propose to effect are considerably wider than those I have brought to your notice at present; and here I would point out that a change of propellers can be effected at less cost than any changes in connection with boilers and engines, and that such changes cannot give rise to any trouble after they have been adopted. Every saving of power and increase of speed by the screw propeller which may be effected is of the most far-reaching value in war and commerce, and cannot introduce any countervailing disadvantages, such as sometimes attend the introduction of new forms of engines or types of boilers.

Here I must state that I am aware that, in proposing to increase the width of the end of the blades, I am reverting towards the earlier form of blade—and abandoning the fashion introduced by the late Mr. Griffiths. But I must point out that the conditions now are different from what they were forty or even fifteen years ago; also *that the locality of the propelling surface is of as great importance as the proportion of the area of that surface to the maximum i.h.p.* For *one* square foot of surface at or near the periphery is equivalent to at least *eight* square feet at or near the semi-radius of the blade. Thus it is possible to have propeller blades of 100 square feet of area arranged with narrow ends and great width near the boss, and yet making more revolutions with a given h.p., and giving less speed and efficiency than another propeller of the same pitch and diameter, and less total helicoidal area, *but having greater width at the ends of the blades and less width near the boss*.

It has required many years of scientific research and hundreds of trials to bring the ordinary radial-surfaced screw to its present condition of efficiency,

and I therefore trust that the system I propose may have a few preliminary trials in order to develop its highest possibilities. A large number of trials of vague, rule-of-thumb changes, is not desired, and is not necessary, but certain developments should be proceeded with cautiously, according to the indications progressively given by the earlier trials which may be made by this propeller.

MULTIPLE PROPELLERS.

Multiple propellers were employed nearly fifty years ago, and the turbine system is bringing them again into notice. For nearly thirty years I have advocated triple propellers, *with three isolated engine-rooms*, in order to obtain as much security as possible for some portion of the propelling power during battle. There are, in my opinion, as a mere sea-going engineer, a dozen good reasons for the adoption of triple propellers in large high-speed ships for every single reason urged against it. I cannot consider that certain foreign Powers, such as Russia, France, and Germany, have been hasty and injudicious in adopting triple propellers for their large warships. Germany, alone, has nearly forty large warships built and building with triple propellers, and I hope that we may soon give triple propellers a trial in some very large ships. Admiral Melville, of the United States Navy, has so admirably stated the case for triple screws that I have nothing to add to that which he has said.

The introduction of triple screws in vessels where there is an installation of over 20,000 h.p. is just as logical a development of machinery design as the introduction of twin screws was a generation ago.

EXPERIMENTS ON THE EFFICIENCY OF CENTRIFUGAL PUMPS.

IN this paper, read before the Institution of Mechanical Engineers, the author, Mr. Thomas E. Stanton, D.Sc., describes a number of experiments which he made in the Hydraulic Laboratory of University College, Bristol, in order to obtain, if possible, further information on the losses of efficiency in these pumps, and the means of reducing them.

The author's conclusions were as follows :—

1. In high-speed wheels, *i.e.*, wheels in which the velocity of the tips of the vanes exceeds 40 ft. per second, the effect of moderately recurving the vanes at the outlet is beneficial (especially when the water is discharged into a free vortex), the curvature being such that the velocity of flow of water through the wheel is uniform.

2. Wheels which discharge the water into guide passages give a higher efficiency than those which discharge the water into a free vortex, this advantage being more marked in the case of wheels with radial vanes than in the other type.

3. The number of guide passages should be not less than four, and the areas at inlet should be such that the velocity of flow into the passages should be equal to the velocity of discharge from the wheel, to avoid losses from sudden changes of velocity.

As regards any modification of the existing design of centrifugal pumps, the author ventures to suggest that increased efficiency and considerable economy in material and space occupied would result in the adoption of a high-speed pump driven direct from the motor and designed on the principles laid down above. For dealing with very large quantities of water at a low lift, no doubt the present slow-speed pump driven direct from a steam engine has great advantages, but for supplying moderate quantities of water at high—or moderately high lifts—the high-speed motor-driven pump is very suitable. When the simplicity of construction and small cost of centrifugal pumps is considered, it seems remarkable that the use of them should be so limited. This is perhaps due to the impression which has till recent years prevailed that these pumps were useless at other than quite low lifts. Now that their adaptability and satisfactory working at high lifts is being recognised, there seems every reason to suppose that they will come into use in many cases where reciprocating pumps have hitherto been solely employed.

THE USE OF COPPER FOR STEAM FITTINGS.

ACCORDING to Mr. W. E. Storey, who read a paper on "Some Applications of Copper in Engineering Practice" at a meeting of the Manchester Association of Engineers, an impression prevails that as a material for use in the construction of pipes and vessels in connection with steam service, copper at the present time is under a cloud.

The conditions under which it was now frequently applied had increased in stringency, particularly along the lines of higher pressures and temperatures, and largely because of a lack of progress in design to meet these conditions, due to a want of knowledge of the possibilities and limitations of the metal. He hoped to be able to show how by careful attention to design on the part of the engineer, and to production and treatment on the part of those who combined to supply him with either the materials for his own manipulation, or the finished copper products, the advantages which undoubtedly attended the use of copper and its alloys might be safely utilised.

The main claims that copper had to consideration, and in fact to pre-eminence amongst the metals of commerce, so far as its special qualities were concerned, were (*a*) its high electrical conductivity, (*b*) its capacity of conducting heat, (*c*) its extreme ductility, and (*d*) its resistance to corrosion. On the first of these he had nothing now to say ; the second and third taken together might be said to be of extreme importance to engineers ; while the last also had its interest, for such uses of copper as the manufacturing chemist, the calico printer and bleacher. Copper gained its place in the regard of engineers because of its unequalled power of transmitting heat and its great ductility, which enabled it to be worked into intricate forms with ease to the operator and without fatigue to the metal. A common cause of deterioration in the quality and strength of copper was its contact whilst hot with a reducing gas. These conditions caused a chemical change in the copper, rendering it brittle, and the effect could easily be produced on the brazing hearth by allowing the fire to be sluggish and short of the requisite amount of air-blast. Carelessness in that respect on the part of the workman was one of the most serious dangers copper had to meet.

Although copper had many virtues, as a material for the use of engineers, there were certain faults attaching to it. Amongst these were the following : For the conductivity of either electricity or heat purity was an advantage, but chemically pure copper had very little resistance to wear. Its ductility formed its most important advantage to the coppersmith and the makers of plates, tubes, rods, and so forth ; but this ductility was

gained at the cost of a very low elastic limit. Notwithstanding the loss of strength resulting from subjection to high temperatures and to the action of certain gases, copper remained incomparably the best material for many purposes in the general practice of engineers.

THE TRANSMISSION OF POWER BY ROPES.

A VERY complete paper on the Transmission of Power by Ropes was read at a meeting of the Staffordshire Iron and Steel Institute by Mr. Edwin Kenyon.

Remarking that rope driving may be divided into two leading branches, known as the American or Continuous System, and the English or Individual System, the author carefully examined the relative value of each. He first dealt with the American or Continuous System—that of winding a long rope round and round the pulleys, and then carrying it from side to side as it completes the circuit, by means of a jockey pulley fixed at the required angle.

This system, it will be observed, necessitates a series of deflections from the straight driving path, causing the rope to assume the form of an elongated spiral, and setting up a one-sided pressure in the grooves until it (the rope) passes on to the arcs of contact. If the weight upon the "jockey" pulley is so arranged as to merely take up the slack and balance the driving tension of that part of the rope which it controls, then the frictional loss due to carrying the rope across the pulleys is not a very damaging factor; but when it is overloaded with a view to levelling up the entire drive, the strain, as may be imagined, is very materially increased, without accomplishing its object.

In order to understand better this method of driving, let us introduce ourselves to what was, up to a short time ago, one of the best examples on this side of the Atlantic, but which is now transformed to the single rope system

GRAIN ELEVATOR DRIVING.

In this instance the full load was transmitted from the engine to the main shaft by separate cotton driving ropes, and then conveyed to grain elevators by means of Manilla ropes, fitted up on the American system by the firm supplying the machinery. When in full action this continuous drive displayed a most interesting phenomenon, which offered rebutting evidence to the much-vaunted tension equality theory. Looking directly down the driving line, a distinct deviation from the presumed horizontal plane was observable along the whole width of the drive. At the commencement of its circuit the rope was seen to reach its highest tension, from which it gradually declined at regular intervals, marked by its passage from groove to groove, reaching its lowest point at the last lap, to renew and repeat the operation so long as it continued to work. When we take into consideration that the grooves form part of the driving pulley, and are not loose sheaves like those of a pair of blocks, it will be readily understood that the wedging action prevents any interference with the original tension at which the rope is fixed, save by the strain on the working side, unless the rope stretches unduly, or is made to slip, and that such a process would be fraught with loss of power.

Doubtless the greatest hindrance to the general adoption of the American system for all purposes is the fact that dependence has to be placed upon one rope; should that fail, the driving must stop until it is replaced. With the separate rope system, an excess of the actual power required being usually provided, the replacement of a rope may await a convenient season, and that without detriment. We do not propose a wholesale condemnation of this system; there are circumstances where continuous rope driving may be adopted with advantage over other methods—for instance, in its application to paper-making machinery, and under other awkward conditions. An advocate of continuous driving recommends pulleys of not less than sixty times the diameter of the ropes.

THE INDIVIDUAL ROPE SYSTEM.

The author proceeded to discuss at length the considerations bearing upon the relationship of ropes with pulleys, under the conditions governed by the Individual System. He remarked that—

The absolute point of detraction in power from the employment of relatively small pulleys cannot, of course, be determined with mathematical accuracy, by reason of the elastic medium with which we have to deal, which elasticity varies with almost every make of rope. We must, therefore, be content to declare a position between the extreme limit where the bending faculty of a rope ceases to exert its influence, and the radius controlling the highest capability with which we are acquainted. By reason of the great disparity in elasticity between cotton and Manilla, what is known as "permanent set" (*i.e.*, where elasticity altogether ceases) being reached at a very much earlier stage in the tension of the last mentioned, is has been found necessary to fix the smallest pulley diameter at 50 per cent. greater than that of a cotton rope. For the efficient transmission of power, the smallest pulley used with cotton ropes should not be less than 30, and with Manilla 45 diameters, unless extra rope power is added to make up for loss of grip.

GROOVES.

The paper contained a number of useful suggestions as to awkward conditions of rope transmission, and some valuable information on the subject of grooves. The author described the latter as the most important item in the whole economy of rope transmission, at least so far as mechanical arrangements are concerned. Incidentally he remarked that—

At one time it was an accepted theory with many engineers that grooves should bear some resemblance to the rope itself, and therefore curved sides were introduced in the belief that they afforded a necessary ea ement to the rope when leaving the grooves. When grooves of this description are employed we generally find it necessary to increase the diameter of the rope to the utmost limit, not only to make up for loss of power, but to prevent, as far as possible, the rolling action often induced thereby.

The angle at which driving rope grooves are constructed vary as much as from 54 degrees to 15 degrees, the latter being applied to the driving of cotton machinery with small bands, and from the results obtained it would appear that every diameter of rope has its most appropriate angle. While this need not be carried to the extent of providing a range of templets to cover all sizes, some line of demarcation between the acute and abtuse is advisable.

One firm of engineers works to four different angles, beginning with 30 degrees for small ropes, from [illegible] in. to [illegible] in. diameter, 36 degrees from 1 in. to 1¼ in., 40 degrees from 1⅜ in. to 1⅝ in., and 45 degrees from 1¾ in. to 2 in.

What we advocate is 30 degrees for all driving ropes under 1½ in. diameter and 40 degrees for all above that size, including the 2 in. diameter. Indeed, from what we know of the working of 1½ in. ropes in angles of 29 degrees, we have no hesitation in declaring our belief in the former angle for all diameters, excepting the small machine bands. Acute grooves certainly afford a check against revolving action.

ADDRESS BY THE PRESIDENT OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

(Abstract continued.)

THERE were now established in Great Britain 13 two-phase and 5 three-phase stations, exclusive of power-transmission stations. In 29 cases supply was given on two or even more systems. Many of the alternating-current stations had taken up the supply of direct current, others had added two-phase or three-phase supply to their single-phase service, or had changed over completely to one of these. The direct-current system appeared to be in no immediate danger of supersession, in part owing to the raising of the voltage, and the consequent possible extension of the service area. The number of voltages in use was somewhat confusing, and presented to the Standards Committee a difficult problem to solve. These voltages now amounted to about 16, and out of 289 examples of pressures, nearly one-third were declared at 230, more than one-sixth were given as 220, while voltages of 240, 200, and 100 claimed about one-eighth each. There were between 50 and 60 stations which revelled in more than one declared pressure. The extent to which the change from one voltage to another had taken place might be judged from the fact that in 234 cases the pressure was upwards of 200 volts; 64 supply current both above and below 200, and there were only 29 whose supply was entirely under 200 volts.

Since the establishing of the Portrush electric tramway in 1883 the electrical engineer had encroached on the field of the tramway engineer, and, consequently, the purely tramway work, as apart from the electrical work, had often shown the mark of the active, clever, but untrained mind, impossible curves and grades being attempted, and unnecessarily expensive work being done. There had been some advantage in this, no doubt, as the experience gained by these works, although expensive, had tended to improvements in practice. There was an American manner in this mode of procedure which led to a free use of the scrap heap. The golden rule, "Be sure you are right, and go ahead," was the best to follow, but it often happened that one died and was taken from the arena before even the first part of the rule was complied with. On the whole, therefore, it was perhaps as well that chance should be allowed to play its part, and that activity and energy should not be troubled with a too severe bearing-rein. Already many of the paymasters were questioning the scrap-heap theory, as they knew by experience that this was often evolved from nothing but a craving for change and a want of appreciation of the true value of money on the part of their advisers. These remarks were made with no desire to convey the idea that work in this country was not carried out conscientiously and well, but rather with the view of suggesting a curbing of the expenditure of money which produced a semblance for the moment of unbounded prosperity, while in reality it only meant riding full gallop for a fall. If the fall should occur, the many men who were entering the ranks every day and swelling the numbers would find their prospects blighted owing to a disturbance of the trust which was placed in the electrical engineers of to-day by those who supplied the sinews of war. Mr. Gray therefore thought it incumbent on every electrical engineer to carefully weigh every recommendation he might make, not from the point of view of immediate, but rather from that of ultimate efficiency, and to deal with every possible factor in drawing his estimates.

THE ELECTRIFICATION OF RAILWAYS.

The application of electric traction to our railways was progressing. At present the sections which were being dealt with were those which had a great traffic density or a frequent service. This policy was doubtless a wise one, as the railway companies limited the application of a considerable capital expenditure to the best paying division of their lines, and to those portions where the benefits to be derived were the most apparent. During the current year the first section of the Metropolitan-District Railway conversion had been made, and it was expected before March of next year that the Moorgate Street-Drayton Park and Drayton Park-Finsbury Park sections of the Great Northern and City Railway Company would be in operation. The Mersey Tunnel Railway had been completed, and the conversion of the Wirral Railway was under consideration. The North-Eastern Railway had had trial runs along Tyneside, and good progress was being made with the Liverpool-Southport line. The Central London Railway was completing the change from locomotive to motor-car driving. The motor-car system was generally accepted as the best form for passenger traffic for many reasons which need not be recapitualted. The direct-current system at 500 to 700 volts appeared to remain as a standard for railway work of this class, as well as for tramway work, but there were signs that single-phase alternating current might prove a rival. In the United States the Washington Annapolis Railway was being equipped with an overhead system, which would deliver direct to the motors a single-phase current at 3,000 volts. The three-wire system of feeding tramways and railways, though not without examples abroad, had not been adopted in this country save on the City and South London Railway, where it seemed to have proved satisfactory.

ACCUMULATORS.

Although accumulators were being extensively used for private carriages in London and elsewhere, yet this country had not seen its way to employ them for rail or tramways. In Italy and Germany some use was made of them, and it was stated that, as the result of two years' working on lines running out of Bologna, the cost of battery traction had proved 28 per cent. cheaper than steam. The use of storage battery locomotives in America for shunting and mine work appeared worthy of mention, as it seemed to have attained considerable proportions, and to have proved successful in practice.

The address also dealt with the growth of the Institution, touched upon some of the most notable electrical projects at present in progress, surveyed the status of submarine telegraphy, briefly reviewed the work of the Engineering Standards Committee and called attention to the present functions of electro-chemistry.

BOOKS OF THE MONTH.

"PRACTICAL CONSTRUCTION OF ELECTRIC TRAMWAYS."

By William R. Bowker, C.E., M.E. E. and F. N. Spon, Ltd. 6s. net.

An excellent treatise on electric tramway construction with numerous diagrams. The author's treatment being essentially practical, he at once dips into the question of laying out the permanent way. Chapter II. is devoted to the preparation of a substantial road bed foundation, without which, as the author points out, it is useless to expect reliable results. With the aid of numerous diagrams, he then describes the laying of the rails, plate laying, bonding, etc. As to the completion of roadways, the author notes that no pavement has yet been discovered with so long a life as granite sett pavement, properly laid with judiciously selected granite or syenite. There is a good deal of useful information anent wood-paving. The details connected with the overhead equipment are carefully considered, and the author includes notes and details on materials used in the construction of the Manchester, Brighton, Lancaster, and other well-known tramway undertakings. It is highly important and desirable to be able to localise faults in the tramway system, and a whole chapter is therefore devoted to the testing and maintenance of electric tramways. It is intended in the near future to increase the scope of the work, and to introduce some additional information relating chiefly to the slotted conduit system of electric traction, and also to electric, street, underground, and elevated railway systems. In the short space of 111 pages the author has given a most instructive view of the practical construction of electric tramways.

"WATER SUPPLY."

A Student's Handbook on the Conditions governing the Selection of Sources and the Distribution of Water. By Reginald E. Middleton, M.Inst.C.E., M.I.Mech.E., F.S.I. Charles Griffin and Co., Ltd. 8s. 6d. net.

The engineering student will here find an excellent compendium of the subject, in which special prominence has been given to such questions as the quality of water, the interpretation of analyses, the stability of masonry dams, the flow of water through pipes, and the general application of mathematics to the subject. Incidentally, the author calls attention to the fact that there are but few rivers and streams in England which are accurately and systematically gauged. One of the first questions to be answered in designing new water works is the amount of rainfall in the district under consideration, yet, notwithstanding the labours of Professor Symons, his successor, Mr. Sowerby Wallis, and others, the information obtained is far from perfect. The writer is strongly of the opinion that the utmost publicity should be given to all the knowledge which exists on the subjects referred to; but the work, to be complete, should not be directly in the hands of private individuals, but of conservators of the several drainage areas into which the country should be divided for purposes of the prevention of pollution of rivers and streams, water supply, and drainage. Their duty should consist in safeguarding the waters under their authority from pollution, in utilising them to the best advantage both from a sanitary and economical point of view, and in preventing, so far as their powers extend, the wasteful and unnecessary duplication of small sewage disposal works. Finally, they should not only be empowered, but be under the obligation, to systematise the rainfall statistics within an area of each, to ascertain the flow of the main river under their charge, and each of its tributaries, to keep a record of the changes of level in a number of representative wells, and to publish within a reasonable time the whole of the information so collected. The towns, in like manner, should be obliged to afford to the conservators full and accurate information as to the extent of their drainage area, the rainfall in it, the water collected from it, the water supplied to the town, and its uses.

"THE HANDYMAN'S BOOK OF TOOLS, MATERIALS, AND PROCESSES EMPLOYED IN WOODWORKING."

Edited by Paul N. Hasluck, with 2,545 Illustrations and Working Drawings. Cassell and Co., Ltd.

This well-printed and illustrated work fully sustains its claim to be a practical book on practical handicraft in wood. Having described the various kinds of tools employed in woodworking, the author proceeds to easy examples of woodwork. In the subsequent pages he treats extensively of the further numerous applications of the handicraft, including outdoor, domestic, and office furniture. The volume teems with hints which should be useful both to the amateur and to the mechanic. There is a chapter on lathes, turning and turnery, and the utility of the work is greatly enhanced by a complete index.

"ACETYLENE: THE PRINCIPLES OF ITS GENERATION AND USE."

By F. H. Leeds, F.I.C., F.C.S., and W. J. Atkinson Butterfield, M.A., F.I.C., F.C.S. Charles Griffin and Co., Ltd. 5s. net.

Acetylene has latterly found such an increasing use that this work—a practical handbook on the production, purification, and subsequent treatment of acetylene for the development of light, heat and power—makes an opportune appearance. It is a comprehensive treatise and is to be strongly recommended to those who are making a study of the subject. The special aim of the author has been to explain the various physical and chemical phenomena: (1) accompanying the generation of acetylene from calcium carbide and water, (2) accompanying the combustion of the gas in luminous or incandescent burners, and (3) its employment for any purpose—(a) heat, (b) compressed into cylinders, (c) diluted, and (d) as an enriching material. There are many useful tables, one of the most interesting giving the cost per hour of lighting respectively by acetylene, petroleum (paraffin oil), coal gas, candles and electricity.

"THE WONDERFUL CENTURY."

The Age of New Ideas in Science and Invention. By Alfred Russel Wallace. Swan Sonnenschein and Co., Ltd. 7s. 6d. net. New edition, revised and largely re-written, with 107 illustrations.

This very interesting book for occasional reading, has been improved by the omission of a long dissertation on vaccination. In place of this, notes have been added on locomotion by land and sea, photography, engraving, chemistry, electricity and astronomy. In a work in which so much has been attempted there is necessarily a good deal of superficiality, but enough is said of the various subjects to stimulate interest and to open the way for further study. This superficiality for instance is particularly noticeable in the section dealing with wireless telegraphy. The half-tone illustrations are not a strong point.

"THE ELEMENTS OF ALTERNATING CURRENTS."

By W. S. Franklin and R. B. Williamson. Second edition, re-written and enlarged. Macmillan and Co., Ltd. 10s. net.

In this work the principles of alternating currents, and the theory of the various types of alternating current machinery, have been rendered as intelligible as possible to the student. Five chapters have been added covering the ordinary types of alternating current apparatus, and showing the conditions under which it is operated; these are intended to be read in connection with the theoretical sections of the work. The numerous additions include a complete series of practical problems with answers, and especially noteworthy are the alterations in the chapters on the alternator, the transformer, the synchronous motor, the rotary converter and the induction motor.

"ELEMENTARY TELEGRAPHY AND TELEPHONY."

By Arthur Crotch. With numerous illustrations. E. and F. N. Spon, Ltd. (London) and Spon and Chamberlain (New York). 4s 6d. net.

One of the Finsbury Technical Manuals edited by Professor Silvanus P. Thompson, D.Sc., B.A., F.R.S., M.I.E.E., etc., this work is intended to give the student in this special field a thorough grounding in leading principles. Its scope will be sufficiently indicated by the following synopsis of contents: Magnetism; terrestrial magnetism—magnetic theory; static electricity; electrostatic induction—condensers; dynamic electricity—the voltaic cell; primary and secondary cells; resistance, current and electromotive force; effects of current—galvanometers; induction; cross-section—combined resistances; joining-up of cells—universal battery system; telegraphy; single needle—sounder; relays—double-current working, etc.; Wheatstone A B C—Stelje's recorder; differential duplex; bridge duplex; submarine; the telephone; telegraph and telephone lines; elements of testing. The treatise is well printed and illustrated; great care has obviously been expended in its production, and owing to its concise arrangement it should save the student of telegraphy and telephony considerable trouble in getting at the elementary facts of the subject.

"THE PRACTICAL ENGINEER POCKET-BOOK FOR 1904."

Technical Publishing Company, Ltd., Manchester. 1s. net. Leather gilt, with diary on ruled section paper, 1s. 6d. net.

An astonishing amount of information for ready reference in small compass has been included in the sixteenth annual edition of this pocket-book. It has been revised and brought up to date, and should be in the hands of every practical engineer. Among the illustrations and additions may be mentioned a description of the water-tube boiler of the Stirling Company of U.S.A., the Daimler motor and the notes on patents and patent law.

"THE PRACTICAL ENGINEER ELECTRICAL POCKET-BOOK AND DIARY, 1904."

Technical Publishing Company, Ltd., Manchester. 1s. net. Leather, gilt, with diary on ruled section paper, 1s. 6d. net.

On similar lines to the above, this useful auxiliary has now reached its fifth annual edition. It includes this year the standards of electrical conductors, as recommended by the Cable Makers' Association, some additional facts in reference to conduit wiring, and some new types of electrical instruments.

"ELECTRICITY AND MAGNETISM."

An Elementary Text-book, Theoretical and Practical. By R. T. Glazebrook, M.A., F.R.S. Cambridge University Press. 7s. 6d.

Presents the A B C of electricity in numbered paragraphs, and offers the young student a good grounding in the subject. Between the time-worn experiment with a pith ball on the first page, and the observations on the electron theory of matter which concludes the work, many experiments are given and lucidly explained, while the student can test his progress by means of carefully arranged examples, to which answers are furnished at the end of the volume.

"BROWN'S COMPREHENSIVE NAUTICAL ALMANACK."

Harbour and Dock Guide and Advertiser, and Daily Tide Tables for 1904. James Brown and Son (Glasgow). Simpkin, Marshall (London). 1s.

This handy work of reference has a full digest of the astronomical and other phenomena required for the purposes of navigation; complete list of lights, fog signals, beacons, and buoys on coasts of the United Kingdom, with lights and fog signals in the Baltic and North Sea, etc. The publishers have, in this edition, for the first time given the tidal constant for every port of Great Britain and Ireland, with the depth on sill of every dock and harbour, as well as an elaborate table of tidal constants.

OUR DIARY.

November.

23rd.—Labour riots and strikes reported from America.—President Roosevelt receives Lord Lyveden and Dr. S. Lunn who are arranging an English Parliamentary visit to the St. Louis Exhibition next autumn. — International Sanitary Conference concludes its meetings at Paris—the establishment of an International Sanitary Bureau in Paris not agreed upon, several of the Powers being opposed to the scheme.

24th. — The Royal Commission on Coal Supplies resumes its sittings.—Death of Mr. Siegmund Loewe, a director of Messrs. Vickers, Sons and Maxim, consequent upon injuries sustained in a motor-car accident.

25th.—Annual dinner of the Institution of Mining and Metallurgy—speech by Sir W. Anson, M.P.—Inventions Exhibition opens at Brighton.—Representatives of both Houses of the British Parliament visit Paris. — Death of Mr. William Cochrane, coal owner and ironmaster, of Newcastle.

26th. — Issue of Parliamentary paper containing abstracts of the returns made to the Board of Trade of shipping casualties on our coasts during 1901-2.

27th.—The majority and minority reports of the Native Labour Commission published at Johannesburg.—Mining accident at Grassmoor Colliery, near Chesterfield.—An electrical department, distinct from all other departments, organised in the Devonport dockyard.—Mr. C. Salter lectures at the Liverpool University on "Ankylostomiasis in Mines."

28th.—The Great Western Railway Company announce that they will proceed immediately with their scheme for the construction of a new harbour at Weymouth.—The Highways Committee of the London County Council issue its regulations under the Motor Car Act, 1903.—Settlement of the colliery strike at Acton Hall, Yorkshire, which caused 2,000 of Lord Masham's employés to be out of work.

30th. — Great distress reported from Cape Colony owing to the arrival there of large numbers of people for whom no work can be found.—Death of Sir Frederick Bramwell.—Anniversary meeting of the Royal Society.

December.

2nd.—Mr. Wybergh, the Commissioner of Mines in the Transvaal resigns.— Labour troubles reported from the United States—it is announced that employers in every branch of building industry will meet in convention for the purpose of organising a national association to fight against the demands of labour.—The Automobile Club decides to form an association for motor and van users, its object being to represent the views of motor and van users before the Local Government Board, and to resist undue restrictions, etc.

3rd.—The British Admiralty purchase the two battleships constructed at Elswick and Barrow for the Chilian Government.—Second-class cruiser *Flora* goes ashore at Denman Island, and is likely to prove a total loss.—An anonymous donor presents £50,000 to the London University College "for the promotion of higher scientific education and research in that institution."

4th.—The Chamber of Trade, meeting in Johannesburg, passes a resolution affirming the necessity of imported coloured labour under restrictions.—The *Times* learns that an agreement for the amalgamation of their Mediterranean-American services has been concluded between the White Star and Hamburg-American Lines.

5th.—A deputation waits on the Lieutenant-Governor of the Transvaal to urge the desirability of a *referendum* before legislation is passed dealing with the importation of Chinese labour. — Serious railway accident on the London and North-Western line near Penrith.—Launching at Belfast of a new Union Castle liner, *The Kenilworth Castle*.

7th.—The session of the Legislative Council opens in Pretoria. The Lieutenant-Governor remarks that the Council will be asked to discuss whether it is advisable to supplement the supply of labour available in Africa by the importation of indentured labour.

8th.—Members of the Johannesburg Stock Exchange unanimously pass a resolution urging the Government to authorise the importation of coloured labour—there is good authority for stating that China is not opposing the scheme for Chinese coolies.

9th.—Institution of Electrical Engineers hold their annual dinner.

10th.—The Automobile Club Committee, on the recommendation of the judges, award the medals for the "Reliability" trials held in September.—Motor Car Exhibition opens in Paris.—The Institution of Electrical Engineers celebrate the tercentenary of the death of Dr. Gilbert, of Colchester—presentation made by the Institution to the Borough of Colchester of an historical picture representing Dr. Gilbert showing his experiments to Queen Elizabeth.

12th.—A deputation from the Labour Importation Association wait upon the Lieutenant-Governor of the Transvaal urging the immediate settlement of the question of importing labour.

14th.—Dynamite outrages reported from New York in connection with the building trades' dispute.

15th.—Members of the Johannesburg Stock Exchange demand the immediate settlement of the labour question.

16th.—The Royal Commission on coal supplies meet at Westminter—it is stated that the coal tax has adversely affected trade.

17th.—A public meeting in Pretoria resolves that the question of importation of labour should be deferred until there is a Representative Government.—Launching of the new twin-screw steamer *Durham Castle*.

NEW CATALOGUES & TRADE PUBLICATIONS.

Messrs. Mather and Platt forward two well printed catalogues, which should be obtained by those who are increasing their power plants. The larger one sets forth the advantages of their two Cycle Gas Engines, including perfect scavenging with cool, fresh air, absence of heavy exhaust valves, and removal from the power cylinder of up and down strains due to the resultant of impulse and resistance on the crosshead pin, which in this case is entirely outside the cylinder. Emphasis is laid on the steadier running which results from an impulse at every stroke. The firm claim that they can obtain as high a degree of cyclic regularity, without the aid of excessively-heavy flywheels, as can be got with the best design of steam engine.

The other pamphlet is designed for those who require dynamos of smaller output than those included in the Multipolar Dynamo Catalogue. A range of twelve machines have been designed to meet this want. The three smallest sizes are of the two-pole type; all the larger machines have four poles. In all of them the steel magnet yoke constitutes a casing, with which the pole pieces are cast in one. This constitutes an efficient protection entirely surrounding the armature, while forming a neat, compact design.

T. Weaver and Co. 22, Rosoman Street, Clerkenwell.—From this firm we have received two mounted sheets suitable for hanging on the wall, giving diagrams of their various ebonestos switch-handles and bushes. These are very clearly arranged for reference, and are drawn full size. Particulars of prices are obtainable from auxiliary sheets. The arrangement is certainly a very commendable one, as it enables the eye to take in a comprehensive view of the products of the firm, such as would be impossible in the pages of a catalogue.

United Telpherage Company.—From this company we have received a number of circulars, post-cards, etc., illustrating their Telpherage System. One of these is devoted to the electrical handling of miscellaneous freight. The following are given as the most obvious advantages of telpherage in handling freight. No *crane* or *floor* space is required, the tracks being equivalent to a second story; no *drays* are used on or between the *roads*; *lifting* and *re-handling* are *reduced* to a *minimum*; the loading and unloading are done so rapidly that not only can much of the congestion now noticeable in all important freight yards be avoided, but it is also possible by Telpherage either to *double* the *capacity* of any *freight yard* or to *decrease* its *size* by *one-half*; *smaller storage stations* or *sheds* will be *adequate*, since there will be little delay in sorting the freight and removing it for distribution; the load, whether in the form of boxes, barrels or buckets, can be *deposited just where it is wanted*. *Hand trucking* will be *avoided*, as will also the *slow, laborious lifting* on *box upon box* or *barrel upon barrel*.

William Mills and Co.—An illustrated list of aluminium castings, this being a leading speciality of the firm. The illustrations of castings made for motor cars, engines, etc., are most effectively shown by the employment of black backgrounds. An official report of tests of "Mill's" aluminium alloys, made at the Engineering Laboratory, Durham College of Science, is appended.

Westinghouse Brake Company, Ltd.—An illustrated booklet giving a complete description of the Westinghouse Electro-Pneumatic Signalling System. In a pamphlet issued last year attention was called to the advantages of the system, and an account was given of some notable applications. The present description of underlying principles is supplementary to last year's pamphlet, and is illustrated throughout with excellent half-tone blocks.

Brett's Patent Lifter Company, Ltd.—This company has issued a pamphlet which should be obtained by all interested in drop-forging. The working of their patent steam drop stamps is carefully explained with the aid of numerous half-tone illustrations, a prominent feature being three full-page plates illustrating batteries of drops on this system, installed at Crewe Locomotive Works. There is an interesting extract from articles by Mr. J. G. Horner on Die Forging, and the latter part of the pamphlet is devoted to Power Presses for all trades.

United States Metallic Packing Company, Ltd.—A particularly novel calendar has been issued by the United States Metallic Packing Company, Ltd., of Soho Works, Bradford. This has a large medallion in bas-relief, and a highly artistic colour scheme has been introduced, which is worth a much longer description than we can attempt in the limited space at our disposal. We would suggest that those interested would write to the Company for a copy of this calendar, and it will probably be found advantageous to write early.

The British Thomson-Houston Company, Ltd.—Pamphlet No. 162 is devoted to Automatic Circuit Breakers and is available for binding in the excellent cover provided for the purpose by the firm. The pamphlet points out that circuit breaking devices tend to draw an arc at the last point of contact, which, unless proper precautions are taken, ultimately renders them unfit for use. If such arcing takes place on the main contacts it will rapidly burn them and destroy the contact surfaces. It is therefore essential to break the arc away from the main contacts either by the provision of secondary contacts which open circuit slightly later than the main contacts, or by forcing the arc on to portions of the contact pieces, which do not form part of the contact surfaces. To reduce the destructive action to a minimum the arc should further be disrupted as rapidly as possible. In the Type M Circuit Breakers of the British Thomson-Houston Company the above requirements are met by the use of the magnetic blow-out. The larger sizes are provided with auxiliary contacts situated in a magnetic field, which disrupts the arc as soon as it is formed, while in the smaller sizes the magnetic action drives the arc on to special arcing tips and then instantaneously disrupts it. In the Type C Circuit Breakers secondary contacts are provided with a quick-break action, and are easily renewable.

THE ADMIRALTY PIER EXTENSION, AND PRINCE OF WALES PIER AT DOVER.

For "A British Naval Station of the Future," see page 129.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining and Allied Industries.

VOL. IV. LONDON, FEBRUARY, 1904. No. 2.

FIG. 8. A WALL SCULPTURE FROM THE NIMRUD GALLERY, BRITISH MUSEUM, IN WHICH MAY BE SEEN A BATTERING RAM AND A CHAIN TO DESTROY THE ACTION OF THE RAM.

THE EVOLUTION OF THE CHAIN.

BY

J. HARTLEY WICKSTEED,

President of the Institution of Mechanical Engineers.

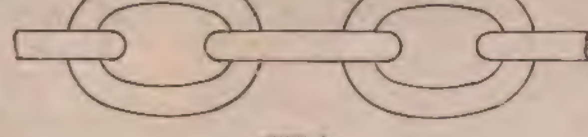
The author traces the evolution of the chain from primitive ages, discusses its various developments in modern times, and includes a unique collection of illustrations.—ED.

TWO PRINCIPAL FORMS.

THERE are two principal forms of construction in chains which we shall find have run through all the ages of chain-making from the earliest recorded times of the human race up to the latest moment in which we live.

The first and most important type is that of a chain constructed of a series of rings, interlinking with each other, so that they cannot come apart without being cut or broken. Each ring is constructed so as to pass through the rings which are next to it, as shown in the sketch of type No. I.

The second type of chain is also composed primarily of rings, but no ring passes through another, and the chain can be taken to pieces without being broken. It is put together by bending each ring till it forms a double loop, and the next ring passes through the loop so



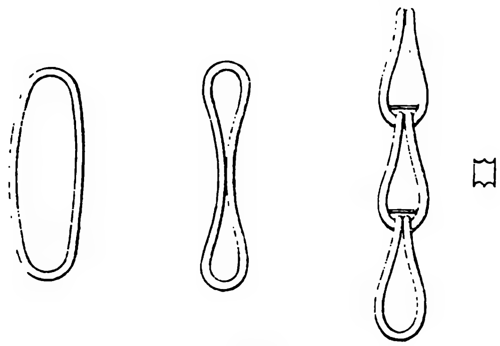
TYPE I.

Photo by Elliott and Fry.

J. HARTLEY WICKSTEED, ESQ.,

President of the Institution of Mechanical Engineers.

formed, but does not pass through the circle of the ring at all. The rings do not interpenetrate each other, and consequently this



TYPE II.

chain can be easily made, as the primary rings of which it is composed require no jointing by welding or otherwise, but can be beaten out of a solid piece, as shown in the sketch of type No. II.

THE ANTIQUITY OF CHAIN-MAKING.

A chain then consists essentially of links or rings connected in a series by interlacing with each other. Ornamental chains are often made of vegetable fibre, of hair, and of gold, and as the earth produces all these materials in their native state, it is possible that such chains were constructed long before chains of silver or brass, or iron. On the other hand, they may possibly have followed after chains of metal as a mere imitation for ornamental purposes. "Necessity is the mother of invention," and to make a flexible band of strong metal the invention of links becomes necessary, whereas flexible bands could be made of grasses without that invention.

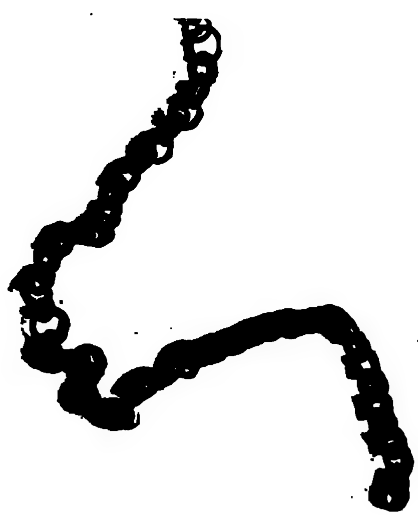


FIG. I. A PLAITED INDIAN CHAIN MADE OF CIRCULAR LINKS FROM FINE SHREDS OF BAMBOO.

Fig. 1 shows a chain made in India of circular links plaited of fine shreds of bamboo. It is a necklet, and purely for ornament, but it has the same principle of construction as metal chains of type No. I.

The ingenuity of making these interlacing rings does not strike one as being so far removed from the ingenuity of other bipeds than man (the weaver bird for example), as the metallurgical processes of reducing ore by fire, and the

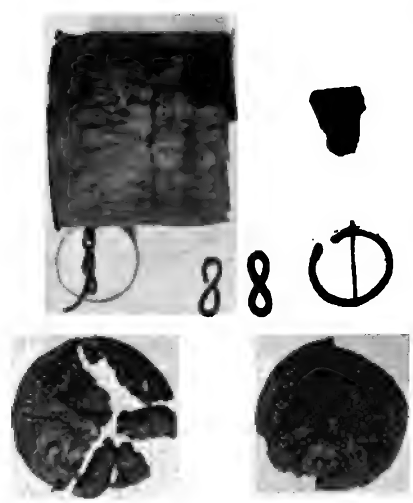


FIG. 2. SPECIMENS FROM THE LEEDS MUSEUM, WHICH WERE FOUND IN A TUMULUS, NEAR THIRSK.

These include fibulæ (or brooches), and a very beautifully worked bracelet, clasped with little chains.

welding of iron, or casting of silver and bronze; and, from this point of view, grass chains may have been invented by primitive man merely from the love of ornament, and without the stimulus of necessity, especially as a catenary curve is such a graceful thing for ornament and for comfort in wearing. If this be so, the antiquity of such chain-making in grasses may be almost that of man himself, who has left

his traces at the end of the last glacial age contemporary with the reindeer in France, very likely 70,000 years ago.

FIG. 3. SYRIAN HEAD-DRESS WITH SILVER CHAINS.*

It will be quite understood that this is not an attempt to fix a date in antiquity for this particular specimen of grass chain, but only to show the possible antiquity of its kind.

EARLY CHAINS IN GOLD SILVER, AND BRONZE.

Next in order of antiquity to fibre would come gold, because it is found in nuggets, and is very malleable in the cold state; also because it is so attractive in appearance. It is natural to find the earliest handicraft devoted to personal adornment, and within the last fifteen months at the ruined city of Abydos, in Upper Egypt, there has been a find of gold ornaments which, according to Professor Flinders Petrie, are probably 6,000 years old.

The illustrations next following show examples which are of silver and bronze, but there is no suggestion of such remote antiquity for these.

FIGURE 8 LINK, VARIETY OF FIRST TYPE.

The specimens shown in fig. 2 from the Leeds Museum, were found in a tumulus, at Sunnybank, Hornby, near Thirsk. They are of bronze, and a flint implement was found with them. There is a fibula, and a very beautifully worked bracelet, clasped with little chains. The chains are nicely formed of bronze wire bent into the figure 8, but not brazed at the ends. They are a variety of type No. I.

Fig. 3 shows a Syrian head-dress, with the silver chains and a piece of silver attached to the end of each chain. This is such a head-dress as was probably possessed by the woman in the parable, who, "having ten pieces of silver, lost one piece and searched diligently till she found it." This ancient chain is made exactly on the construction of type No. II. This type is well adapted for chains of gold or silver, and especially of gold, because it would be beaten out cold from native pieces of gold, beaten into a jointless ring, then bent and looped into a series of jointless rings, making a chain.

The construction of this chain is good, so much so, that ever since patents were established this form of chain has reappeared periodically in the Patent Office.

Fig. 4 shows a bronze chain of the same excellent type. The chains are attached to a large ring, and from one is depending the bronze stopper of a lamp. The rings have been elongated, bent nearly double, and looped together. It was found by Lord Saville at Lanuvium.

FIG. 4. A BRONZE CHAIN OF THE SAME TYPE AS FIG. 3.

The chains are attached to a large ring, and one of them bears the bronze stopper of a lamp.

* This Syrian head-dress is the property of Mr. Aquila Dodgson, who kindly lent it, and also the book and chain shown in fig. 12 to be photographed for this paper.

The old Latin cities, of which Lanuvium was one, existed before the foundation of Rome, and there is nothing to prevent this chain dating from 1000 B.C. This is an example of the value of metal chain where fire is near. Besides being more ornamental than cords of fibre or of skin, a metal chain is more serviceable, in that it resists accidental burning by the lamp. This chain 1000 B.C brings us within the epoch of metal chains other than gold.

ANCIENT TIBETIAN BRASS CHAINWORK.

A Tibetian ornament is shown in fig. 5, consisting of a brooch and chain with tooth-pick attached. The whole is of brass, a beautiful yellow alloy, with the exception of the

FIG. 5. TIBETIAN BROOCH AND TOOTH-PICK.
The whole is of brass, with the exception of the iron pin of the brooch.

iron pin of the brooch. From the imperfect way in which this pin is fixed, we may infer that it was a subsequent addition. It has worn away some of the ornamental face of the brooch, showing that it was actually worn for a long time by its possessor. The chain is made of little hoops of brass interlacing each other, after the type No. I., but these links are not solid, nor are they brazed at the joints, and they would have very little strength to resist opening. It is interesting to see in this ornament an *iron* pin preserved. The fewness of ancient iron relics may arise from the fact that iron, if exposed to damp, rapidly turns into rust, and being chiefly useful for outdoor work and not for ornament, is not often left in a position to be preserved for thousands of years.

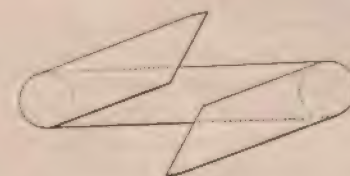


FIG. 6.
The chain-maker having a number of those partially formed at his fire, each link is in turn heated all over, passed through the last link and the scarfed ends are closed.

We have now seen chains for ornament and light use made of plaited grass, silver, and brass, but for heavy use iron is the material of which chains are almost exclusively made.

IRON CHAINS.

Iron differs from other metals in having a plastic weldable condition over a considerable range of temperature between the molten and the rigid state. In this plastic condition the links are easily formed by passing an open ring through a closed ring, and then closing the new link and welding the joint (figs. 6 and 7). Dr. Percy explains this notable characteristic of iron thus: "Iron has one remarkable and very important property—namely, that of continuing soft and more or less pasty through a considerable range of temperature below its melting point. It is sufficiently soft at a bright red heat to admit of being forged with facility, as every one knows, and at about a white heat it is so pasty that when two pieces at this temperature are pressed together, they unite intimately and firmly. This is what occurs

FIG. 7.
After being closed as shown in this figure the scarfed ends are locally heated and welded up.

in the common process of welding. Generally, metals seem to pass quickly from the solid to the liquid state, and so far from being pasty and cohesive at the temperature of incipient fusion, they are extremely brittle, and in some cases easily pulverisable. But admitting that there is a particular temperature at which a metal becomes pasty, its range is so limited in the case of the common metals that it would scarcely be possible to hit upon it with any certainty in practice, or if it were possible, its duration would be too short for the performance of the necessary manipulations in welding. Besides, there is another condition which might interfere with the process.

In order that union should take place between two contiguous surfaces of a metal, it is obviously essential that they should not be covered with any infusible matter, such as scale due to oxidation. In heating iron to the welding temperature, a scale is formed which may be immediately converted into very fusible and liquid silicate of protoxide by throwing a little sand over it, when welding may be effected, the silicate being squeezed out during the operation and clean metallic surfaces brought together. Every blacksmith resorts to this simple expedient of using sand as a flux, but in the case of some of the common metals it would not be very easy, or, indeed, practicable, to find a suitable flux, and to insure this condition."

But though iron has been known for [illegible] years, iron chains of importance are comparatively modern, and the oldest chain of any sort does not date further back than [illegible] years.

Until very recently hemp ropes have been used where strength alone is required, but iron chains have been early used in war, in order to resist fire and sword. War prisoners were bound in chains and fetters of iron, in order that teeth and nails might not sever their bonds. When the Romans invaded Britain they used mooring chains for their galleys, in order that they might not be cut, to set the galleys adrift.

Sir John Oldcastle was said to be hanged in chains [illegible] for the reason that hemp rope would be burnt by the fire, over which presumably he was hanged.

AN EARLY EXAMPLE OF IRON CHAIN.

The wall sculpture from the Nimrûd Gallery of the British Museum is depicted at the head of this article (fig. [illegible]). It is one of a series illustrating the campaigns of Assur-nazir-pal 884 B.C. It is a marble slab entitled Siege of a City. It shows a battering ram and a chain to destroy the action of the ram (fire-water, soldiers, winning ramparts—infantry, bows and shields). It was found by Layard in the N.W. Palace of Nimrûd. The chain is exactly like our type No. I., except that the section of the links is square, instead of being round. If this be an iron chain, it looks like a very early one (or it is made with circular links, like the grass chain and other ornamental chains. But these circular links are not the best shape for strength. Probably before many such chains had been made the blacksmiths would find that the circular links drew out into oval ones, and later chains would naturally be made with links approximately oval to begin with.

On referring to other finds in the mound of Nimrûd Dr. Percy writes:—

"That the Assyrians were well acquainted with iron is clearly established by the explorations of Layard, who has enriched the collections of the British Museum with many objects of iron from Nineveh of the highest interest. Amongst these may be particularly specified tools employed for the most ordinary purposes, such as picks, hammers, knives, and saws. There is a saw similar in construction to that now used by carpenters for sawing large pieces of timber across. It consists of a blade 3 ft. 8 in. long and 4½ in. broad thoughout its entire length, except at one end, where it is narrowed, and was no doubt let into a handle of wood, the rivets being visible upon it. It was found in the North-west Palace of Nimrûd, and could not be in date later than 880 B.C. The fact of iron having been applied to common hammer heads for which bronze might have proved a tolerably good substitute, indicates that iron was certainly as cheap, if not cheaper, in those days than bronze, and the correctness of this inference is strikingly confirmed by many other objects from the same locality, consisting of cores of iron around which bronze has been cast."

We therefore see that in 880 B.C. the use of iron was in full swing; that it was cheaper at that period than bronze, and that owing to its peculiar welding qualities it was the best material for making strong chain. We may, therefore, conclude that this chain was of iron, and also that it was a very early chain of that material. The circular shape of the links was the most natural form to begin with, and the easiest to make, but that form would not long survive the test of practical experience.

IRON CHAINS USED BY THE ROMANS.

Besides the literary evidence of iron being used by the Romans, we are not without actual samples existing of iron chains made by the Romans, and we can see their form.

The Saalburg, near Homburg, was built and inhabited as a Roman fortress between the years 11 B.C. and 274 A.D., and there is still preserved the iron chain with its hook, which they used for elevating water from a well, also iron chains for horses. These iron chains are welded and are beautifully made, they are of type No. I. The well chain is of a flat rectangular section and oblong, something like the Roman chain which is depicted in a mosaic pavement excavated from Pompeii, and inscribed "Cave Canem." Pompeii was probably founded about 500 B.C., and was buried by lava in 79 A.D. The house was therefore built any time between these dates, and in the floor of the hall immediately behind the double front door was a dog attached to a chain, outlined in black and white mosaic, with the inscription, "Beware of the dog." These veritable examples of earlier iron chains are not of round section, but of rectangular section. This is accounted for by the fact that iron is more easily drawn down from a lump by hammering on an anvil into a flat or square rectangular section than into a round section. This is one reason why the Nimrûd chain may be considered to be iron. The sculpture does not show the links rounded, but flat.

Cæsar mentions that when he invaded Britain 55 B.C., the currency of the people consisted partly of iron rings adjusted to a certain weight. Thus, at the beginning of the Christian era, both the Romans and the Britons had long understood the working of iron. The Romans, as has already been said, used mooring chains for their galleys. They fortified York, and to join the walls across the river they were very likely to place a chain.

This brings us near home. The Romans were established in Britain more than 370 years, and during the space of three centuries and a half they had possessed the country of the Brigantes, of which the present county of York was the principal part. During this long space of time they had completely Romanised the country, and made the same improvements as in the rest of their provinces. The Romans did not leave much to chance, and, in addition to the walls and towers with which they made York impregnable, it is probable that they stretched chains across the Ouse to prevent an enemy's entrance within the city by water. At any rate, chains were used for that purpose later on, as Leland, who wrote at the time of Henry the Eighth mentions, in the following graphic account: "The Towne of York standith by west and est of Ouse river running through it. Thus goeth the waul from the ripe Ouse of the est part of the cite of York. Fyrst a grete towre with a chain of yron to cast over the Ouse, then another towre, and so on to Bowdamgate. From Bowdamgate or bar to Goodramgate or bar, X towres, thens four towres to Laythorp a postem-gate, and soe by a space of two flite shotts the blind and deep water of Fosse, cumming out of the forest of Galtres, defendeth this part of the cite without waulles, then to Waumgate three towres and thens to Fishergate, stopped up sins the Communes burned it yn the tyme of King Henry the Seventh.

Betwixt the beginning of the first parts of this west waulles and Micklegate, be IX towres, and at this XI towres be a postem-gate, and the towre of it is right agayn the est towre, to draw over the chain of Ouse betwixt them."

Of the probable form of the chain here spoken of we have curious indirect evidence.

Upon the Old Ousebridge there stood a chapel dedicated to Archbishop William Fitzherbert (twelfth century). At the Reformation, the chapel was converted into an Exchange for city merchants. Upon the decay of trade, it was divided into a Council Chamber, a Record Office, and a prison for the freemen of the city. The

FIG. 2.—PORTION OF AN OLD ARCH WITH CHAIN MOULDING PRESERVED IN THE HOSPITIUM AT YORK.

building was taken down in 18[illegible]. A portion of the arch in this chapel is preserved in the Hospitium at York. It shows a chain moulding which is a form of ornament found in Norman arches, and strongly suggests the existence of such a chain in the vicinity for the sculptor to have imitated. May it not possibly represent such a chain as even the Romans may have stretched across the river in the early centuries of the Christian era? The links are [illegible] rectangular section but [illegible]

From such a chain as [illegible] twelfth century [illegible] not much [illegible] at York we can [illegible] improvements [illegible] have begun to be [illegible]

MEDIÆVAL BOOK CHAINS.

[illegible]

it was the fashion to chain books in churches and libraries. Many of these chained books are still preserved. The chains used are all either circular or somewhat long in the link, for it was not until 1812 that the perfected form of short oval link, and of links with studs, were made as shown on a subsequent drawing.

For most of the information and views in this section of the subject the writer is indebted to a volume entitled "The Care of Books," by John Willis Clark, M.A., published at the University Press, Cambridge.

Fig. 3 shows part of the bookcase in the Chapter Library at Hereford.

FIG. 3.—PART OF A BOOKCASE IN THE CHAPTER LIBRARY AT HEREFORD.

We will look a little more closely at some of these chains. Fig. 11 illustrates a piece of chain from Hereford showing the swivel, and

FIG. 11. BOOKCHAIN FROM HEREFORD.

FIG. 12. A BOOK AND CHAIN BELONGING TO MR. AQUILLA DODGSON.

it will be noticed that the links are forged of square section, they are long and oval.

In the fifteenth century Cesena, a city of Northern Italy, between Forli and Ravenna, was governed by the powerful family of Malatesta, one of whom built the library in 1452. A part of a bookcase at Cesena is included to show the system of chaining (fig. 13).

FIG. 13. A PART OF THE BOOKCASE AT CESENA, SHOWING SYSTEM OF CHAINING.

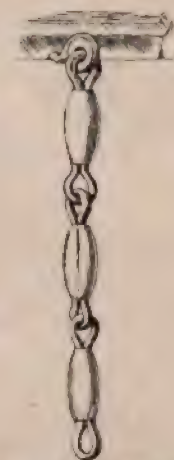


FIG. 14. A CLOSER VIEW OF THE CESENA CHAIN.

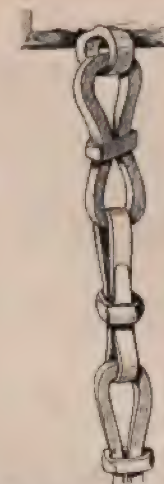


FIG. 15. TYPE OF CHAIN USED IN THE MEDICEAN LIBRARY, FLORENCE.

The chains are of unique form (see fig. 14). Each link, about $2\frac{1}{4}$ in. long, consists of a solid central portion, which looks as though it were cast round a bent wire, the ends of which project beyond the solid part. The chain is attached to the book by an iron hook screwed into the

FIG 16. CHAINED BOOK AT GENT.

lower edge of the right-hand board near the back.

Michael Angelo built the Medicean Library in Florence for Pope Clement VII., which was finished in 1571. Fig. 15 shows the sort of chains that are there. They are made of fine iron bars about $\frac{1}{8}$ of an inch wide, but not

FIG. 17. HARBOUR CHAINS IN THE CLOISTER OF THE BURIAL GROUND AT PISA.

quite so thick, flattened at the end of each link and rounded in the centre, where a piece of the same iron is lapped round. Each chain is 2 ft. 3 in. long. There is a ring at the end of the chain next to the bar, but no swivel.

A volume printed in Bavaria in 1479 is shown with its chain at Gent (fig. 16). The chain is 24 in. long. The links of which there are ten, are compressed in the midddle, so that the two sides touch each other. There is no swivel, but a link rather larger than the rest, is passed round the bar.

It is recorded that Roger L'Isle, Dean of York, in the early part of the thirteenth century, bestowed several exemplars of the Holy Bible to be used by the scholars of Oxford under a pledge. These books were to be locked up in chests or chained upon desks in St. Mary's chancel and church. The practice of having books in chains was abandoned in the eighteenth century.

CHAINS FOR CAPTIVES.

In 1492 Ferdinand, King of Aragon, and Isabella, Queen of Castille, conquered Grenada and overthrew the Moors. They set free the Christian captives from the dungeons, who sent their chains as votive offerings to hang on the church at Toledo, which was built by Ferdinand and Isabella, and called the Church of the Kings, so called because both of the founders were sovereigns in their own right. The chains are chiefly placed within four panels with traceried heads. There are also two chains in the heads of each of the sixteen tall niches beneath the four panels before mentioned.

In the oldest chapel cloister of the burial ground of Pisa there hang upon the wall the chains of the ancient harbour of Pisa, captured by the Genoese in 1632 (fig. 17). They are very much like more modern mooring chains. The cathedral of Pisa was erected after the great naval victory of the Pisans near Palermo 1063, and it is possible that similar chains guarded their harbour at that time.

PORTCULLIS CHAINS.

The portcullis is always pictorially represented with two strong chains. The only place in England where the Portcullis remains is in the Tower of London, where the portcullises of the Bloody Tower and the Byward Tower are still preserved in working order. The apparatus for raising and lowering them, however, consists of a winch with pulley blocks and hempen ropes. The apparatus is in the

tower above the portcullis. There are no ancient chains to be seen in the Tower of London.

CHAINS USED IN BUILDING CONSTRUCTION.

St. Paul's Cathedral, with its celebrated dome, higher outside than inside, was com-

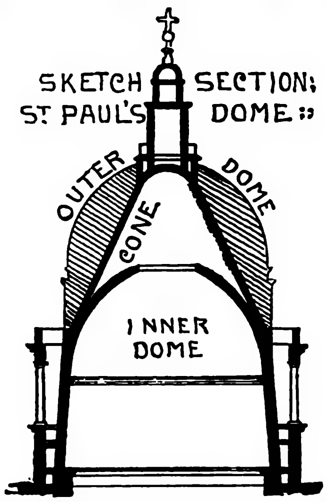


FIG. 18. ILLUSTRATING THE USE OF CHAIN IN DOME CONSTRUCTION.

pleted by Sir Christopher Wren about two hundred years ago, and he put an iron chain round the base of the cone (fig. 18). The construction of the wooden external dome, and the support of the stone lantern by an inner cone of brickwork, quite independent of either the external or the internal dome, are wonderful examples of Wren's constructive ingenuity.

In the "Parentalia," written by Wren's grandson Stephen, partly in his own words, partly in those of his grandfather, is this passage: "Although the dome wants not butment, yet for greater caution it is hooped with iron in this manner; a channel is cut in the bandage of Portland stone, in which is laid a double chain of iron strongly linked together at every 10 ft., and the whole channel filled up with lead." *

CHAIN CABLES.

It has been remarked before, when looking at the mediæval chain ornament at York, that we can find no essential improvement in the form of link, till within the last hundred years, but the old patterns overlap the new, and fig. 19 shows the chain cable of a Russian line of battleship sunk at Sevastopol by the Russians, after the battle of the Alma, and presented to the Leeds Museum by Mr. Henry Dixon. The links are remarkably similar to the Pisan harbour chain, only the section of iron in the older chain is rectangular, being forged out entirely by the hammer, whereas the section of the Russian chain is round, indicating the use of grooved rolls to prepare the round bars, of which the links were made.

Let us now revert to type No. II. We remember the Syrian silver chain made on type No. II. by looping one bent ring through another. In 1791 Colin Mackenzie patented a link to be connected by passing one through the eyes of the other, and in the year 1822 James Gladstone, of Liverpool, patented what he called "an invention of a chain of a new and improved construction." *See* "Traill's Chain Cables and Chains." It hardly has improvements enough over the silver chains in the Syrian head-dress to constitute an invention. It is true that the links are lightly welded together in the middle, and studs were fitted, as shown on the sketch, which is the direction in which this type No. II. has been developed We are now familiar with it in picture chains, bell pulls, etc. Such links are stamped out of brass or steel solid in the middle, and having two eyelets, which are bent together, and through which the next link is passed.

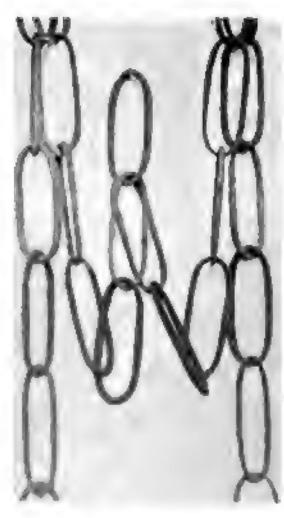


FIG. 19. THE CHAIN CABLE OF A RUSSIAN BATTLESHIP SUNK AT SEVASTOPOL

* The author is indebted for the above information to Mr. Francis Bond, M.A.

About thirty years ago an attempt was made so to improve this type of chain as to make it suitable for ship's cables and rigging, and it was actually used in the French Navy. The name of the inventor was David, but the sample shown in fig. 20 was made by

FIG. 20. TYPE OF CABLE CHAIN USED IN FRANCE.

Brown, Bayley and Dixon, of Sheffield, and was lent for the purpose of this paper by Mr. Robert Armitage, of Farnley.

Nothing better than this sample can be expected from type No. II., but for ships' cables and crane chains, the type is inferior to No. II., because it is not so good a form for winding round a capstan or the barrel of a crab. Also because the eyelets are split, they have their strength divided, and if an oblique strain comes upon the chain they can be broken one at a time. They also present a larger surface for oxidation. This form of chain is, however, largely used-in France for coupling chains on railway trains.

19th CENTURY IMPROVEMENTS.

An admirable account of the history of chain cables is to be found in a book entitled "Chain Cables and Chains," by Thomas W. Traill, C.E.R.N., published by Crosby, Lockwood and Co., and the writer is indebted to that work for the sketches given at the beginning of this paper, and for the historical information which follows in this division of the subject.

It was in 1784 that Henry Cort invented the process of puddling iron and rolling it into rods with grooved rolls. These inventions opened the way for making chain cables with links of uniform section and quality. There had long been a craving for chain cables to take the place of hemp hawsers on ships. Sir Cloudesley Shovel recommended them in about the year 1700. and previously, viz., in 1634, a patent was obtained by an Englishman of the name of Phillip White, blacksmith, for "a way for the mearing of shipps with iron chaynes by finding out the true heating, p'paring and temp'ing of iron for that purpose; and that he hath now attayned to the true use of the said chaynes, and that the same will be for the great saveing of cordage and safety of shipps, and will redound to the good of our co'mon wealth."

No further mention of the use of chain, either as moorings or cables, is made until so far forward as the year 1804. By that time rolled bars of puddled iron were available, and a patent was enrolled by one John Slater, a surgeon of Huddersfield, in the county of York, "for a new and improved method of manufacturing and fabricating of cables, shrouds, stays, and other articles for the rigging of ships of materials never before used for that purpose." No result came of the invention, and the field was still left open for the practical and positive introduction of cables made of chain for the use of the naval and mercantile marine of the world.

This took place in 1808, when Robert Flinn, an Irish blacksmith, whose father fought under General Wolfe, who fell in the elder Flinn's arms, made iron chain cables at his forge in North Shields, which were used in a vessel called the *Ann and Isabella*, built at Berwick-on-Tweed; and in the same year Lieutenant Samuel Brown, of the Royal Navy, fitted out a vessel called the *Penelope* with her entire rigging of chain and with chain for her cables.

Up to this time chain was only known to be made by welding on the ends, and in 1811 many chain cables parted. This led to the introduction of testing machines for proving every part of the cable before it left the works for service. Experiments on the testing machine

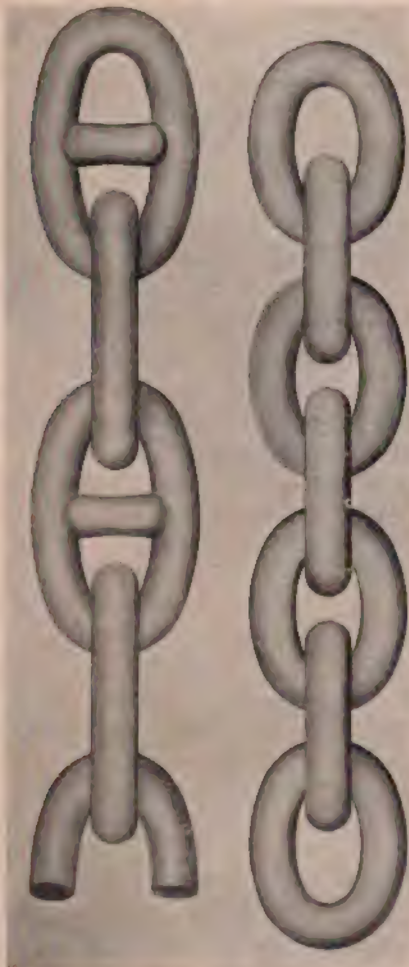


FIG. 21. MODERN CHAIN CABLE.

led to welding the links on the side when made of iron more than 1 in. in diameter, with a long scarf, which gave the men room and iron to work upon. Also it led to the adoption of the stud to keep the links from collapsing, and so to preserve the freedom of the joints, and consequently the cable's flexibility.

MODERN CHAIN CABLE.

In 1816, Brown's second patent, the veritable chain cable of the present, was first made. Previous to that date studs were unknown, and above all short links of only 4½ diams. or even 5 diams. of the iron were unknown. The form of this chain, as shown in fig. 21, is well nigh perfect. It is elliptical, which gives a curve of the same radius as the iron of which the links are made at the inside ends of the links, so that the links bed on each other with surfaces which coincide, while the enlarging radius of the ellipse allows clearance sideways to give flexibility to the chain. The weld is about ·8 of the strength of the bar, and the breaking strength of the chain is about 1·5 of the strength of the bar. But before the breaking strength of an unstudded chain is reached the links become deformed and locked, and the flexibility of the chain is gone. It may, therefore, be fairly argued that the weld does not take away from the useful strength of a chain, but its disadvantage is that it necessitates the chain being made of iron, soft enough to be capable of welding. If, therefore, it be possible to make chain with interlaced links without welding, then very strong hard steel could be used, and the chain of the future could be made of double the strength, weight for weight, of the present-day chain. At first glance it might seem difficult to form interlaced links out of a solid bar, but many a collier in his leisure hours has performed the feat of cutting a wooden chain out of a besom-tail.

But if it be possible to form a wooden chain with solid links it is also possible to form it of hard steel.

Fig. 22 is from a beautiful photograph made for this article by Mr. Crowther, who himself

FIG. 22. A CHAIN IN POSSIBILITY.
Two hundred yards of this chain are in work at the West Riding Colliery, Normanton.

obtained the specimen from which the photograph was made. Although it represents an actual chain, it could not be made to-day for a guinea an ounce. It represents a chain in possibility. Two hundred yards of this chain are in work at the West Riding Colliery, Normanton, and the specimen has been presented to the Leeds Museum by Mr. W. E. Garforth. It is the best piece of chain which they have on the colliery, but no more is forthcoming made as this was.

It will be noticed that there are studs, and the ends of the links are made with a deeper section than the sides, so as to allow for wear. Add to this that it is made of steel. It is an ideal chain, and has twice the strength and twice the wear of a chain made from welded iron rods.

FIG. 23. FIRST STAGE OF THE SAME CHAIN.

Fig. 23 shows the first stage of the process by which it was made. The openings in the links were punched out cold from a bar of cruciform section. The process is too expensive and too wasteful of material to be continued, but it is an ideal chain. Renewed efforts are now being made to produce this ideal chain with commercial success.

Fig. 24 illustrates a method of rolling it hot till it is nearly formed, and shows it at a further stage when the thin films remaining from the rolling have been punched out, but along the centre of the chain bar there still runs a solid rod, which has to be cut out with shaping tools to separate the links; after this the links are heated and squeezed oval.

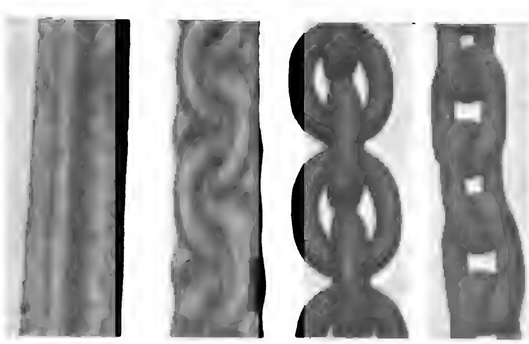


FIG. 24. DEVELOPMENT OF CHAIN FROM THE BAR.

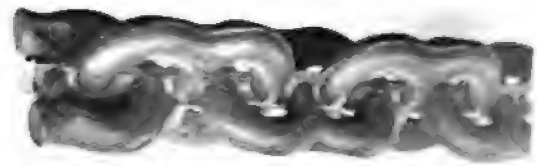
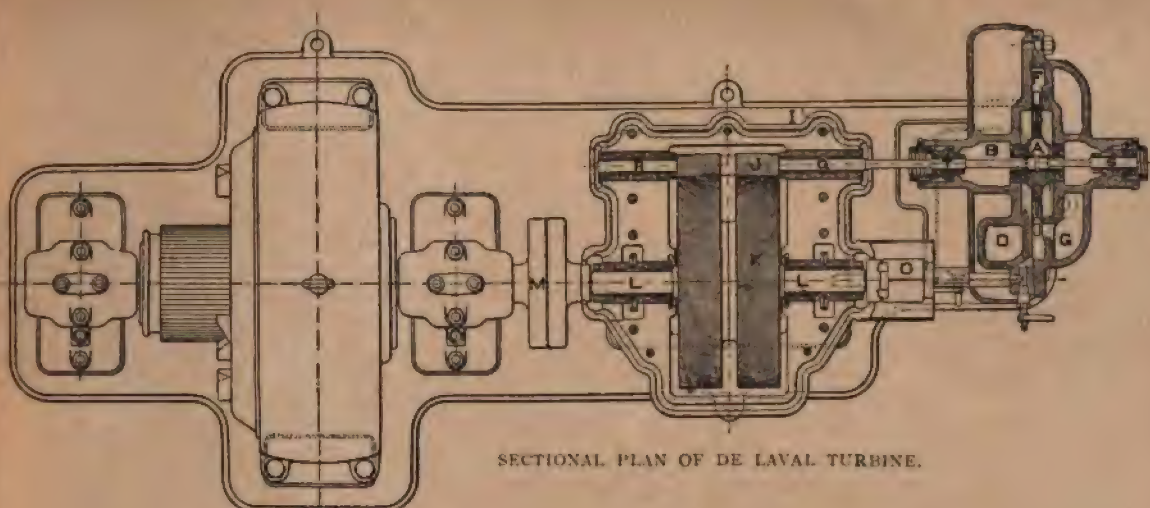


FIG. 25. A CHAIN BAR BEFORE THE ROD IS CUT OUT.

Fig. 25 presents a view of a rolled weldless chain bar after the thin films have been punched out, and before the solid rod running along the centre has been cut out and the links separated, and bent into their finished oval form. This is the chain in possibility.

If a weldless chain of strong steel comes into use in the near future it will bring about a sudden improvement of 2 to 1 upon the chain that has prevailed for a hundred years—that is to say, it will double the strength, weight for weight. Its development arises from an improvement in mechanical art concurrently with the improved production of steel. The chain of the present suddenly doubled the efficiency of all previous chains. It was brought into being owing to the demand for chain cables for ships, together with the improvements in working iron invented by Henry Cort. Before that there was no substantial improvement in chain-making for nearly three thousand years. Previously to 1,000 B.C. we cannot trace the existence of iron chains at all, yet iron itself must have been known and used in Egypt six thousand years ago. It seems, therefore, to have taken three thousand years with the knowledge of iron to make a beginning with iron chains, then there was little or no improvement for a period of three thousand years, when suddenly the beautiful round section oval-shaped short link chain of Robert Flynn, and the stud link chain of Lieutenant Brown in 1812, made a 2 to 1 improvement on the previous square cornered self-destructive chain, and then, after a period of only a hundred years, we foresee another 2 to 1 improvement. The acceleration of improvement may come to us thirty times as swiftly for the last improvement as it did for the previous one.



SECTIONAL PLAN OF DE LAVAL TURBINE.

THE STEAM TURBINE.

BY

HOMER M. JAQUAYS.

Mr. George Westinghouse on a recent occasion said : "The steam turbine is not a new and comparatively untried invention, as many laymen seem to think. There are half a million horse-power of Parsons Steam Turbines in daily operation in different parts of the world ; eighty-four thousand horse-power of these are in steam vessels. In the United States alone there are 60,000 horse-power of a stationary type used in connection with electric light and power in continual operation, and 150,000 horse-power more are already contracted for and are now under construction at Pittsburg, where units as large as 8,000 horse-power are being built. The impression in the public mind that the steam turbine is a new thing, is probably due to the fact that attention is frequently called to new makes of turbines. The fact is, these new types have not demonstrated any superiority over the Parsons, which is the only turbine of world-wide repute and operation, and is the only one which will give, or is at present capable of giving, highly economical results. Other turbines have made claims to economy, but they justify these claims only when they borrow the Parsons idea, which is fundamental. I have made a broad investigation of this question, with the result that the Parsons turbine is the one with which I have concluded to ally my interests. We shall build up a great marine turbine industry in the United States. The importance of the marine turbine has not been overestimated, and it is long past the stage of experiment. We need not call the turbine the engine of the future, it is decidedly the engine of the present."—Ed.

It is interesting at times, in the course of the development of an art, which is progressing in various places and by divers means, to collect as much information as possible concerning it, so that existing conditions may be compared with the past and some insight gained into the possibilities of the future. This fact, perhaps, justifies an attempt to contribute something concerning the steam turbine, even at a time when so much is being published in the current magazines and in the records of engineering societies. The matter in most of these articles is, however, largely made up of reports of single tests or series of tests on one machine and particulars of special turbines ; while the object of this paper is simply to put their information in such a form that the comparisons referred to above may be easily made.

The turbine, the oldest type of steam engine, has always attracted more than an ordinary amount of attention, but the results of the epoch-making events of 1884 and 1889, when patents were awarded the Hon. Chas. Algernon Parsons and Dr. Gustaf De Laval respectively, have increased this interest to an almost unlimited degree. Trevithick, Pilbrow, Wilson, and possibly others, grasped the salient features of the modern turbine ; but it needed modern workshop facilities, with the attendant accuracy of workmanship and attention to detail, to make the turbine a commercial success. And when we realise that it is not twenty years since the application was made for the first letters patent for the Parsons turbine, and that it was as late as 1891 that the first condensing turbine was produced, we cannot but

wonder at the success it has achieved and the world-wide interest it has excited. Previous to the last decade, conservative engineers in general undoubtedly looked askance at rotary engines and turbines; but it needs only a glance at the modern turbine to perceive mechanical features which must meet with approbation, while a closer examination cannot fail to call forth admiration for the ingenuity displayed and the persevering attention to detail shown in every part.

TURBINE TYPES COMPARED.

The modern parallel flow turbine is too well known to need a detailed description, but it will not be amiss to insert here the general principles of its chief types. They all depend for their action upon the conversion of the kinetic energy, caused by the expansion of the steam into work done on the rotating turbine shaft. In the De Laval turbine the expansion of the steam takes place in one or more nozzles before it reaches the turbine blades. In the Parsons this expansion takes place during the passage of the steam through the turbine, while in the Curtis turbine we have the application of both these principles. The De Laval, with its one row of blades, must, in order that the velocity of the steam leaving the blades be not excessive, have a very high peripheral velocity. In the Parsons and Curtis turbines, however, the employment of many rows of stationary and rotating vanes makes it possible to diminish the speed of the turbine shaft without reducing the efficiency.

As regards the velocity of the turbine blades, it is not difficult to find the one that is most efficient. Suppose V_1 be the absolute velocity in feet per second of the steam as it strikes the vanes, and V_2 the absolute velocity of the steam leaving the vanes, the greatest amount of energy that can be given to the turbine per pound of steam is $\frac{V_1^2 - V_2^2}{2g}$ foot pounds, and in order that this should be a maximum, V_2 must equal nothing. This is the case when the velocity of the vane is one-half the velocity of the impinging jet, and when the direction of the motion of the vane is parallel to that of the impinging and leaving jets.

This condition cannot be realised in steam turbines, though it may be noticed in passing that a close approximation to it is obtained in the case of the Pelton water wheel. But the velocities dealt with when working with steam are immensely greater than can ever be experienced with water. Thus, with a head of 200 ft., the velocity of the water entering the turbine could not exceed 113 ft. per second. In the case of turbines of the De Laval type, however, where the steam expands in a diverging nozzle from initial pressure to condenser pressure, it is estimated that velocities of 4,000 ft. or more per second must be employed. This velocity can, of course, be regulated by the form of nozzle. But for economical working, as large a proportion as possible of the heat energy of the steam must be changed into the kinetic energy of the gas, the velocity of which, since it has a large specific volume, must be very high. It is stated above that for maximum efficiency the velocity of the vane should be one-half the velocity of the impinging jet. But a vane velocity of 2,000 ft. per second would, of course, cause such centrifugal forces in the turbine wheel as no known material could safely bear. Turbines, with a single row of vanes using high pressure steam, must consequently run at a speed lower than the most efficient—a peripheral velocity

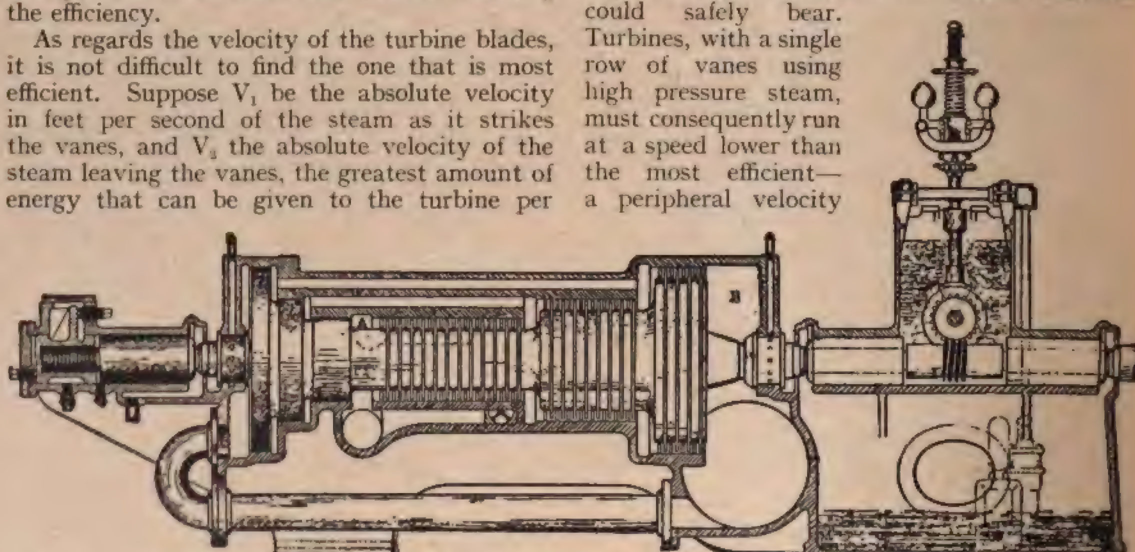


FIG. 2. LONGITUDINAL SECTION OF THE PARSONS TURBINE, AS MANUFACTURED BY THE WESTINGHOUSE MACHINE COMPANY.

The Westinghouse Parsons Turbine is manufactured in this country by the British Westinghouse Company.

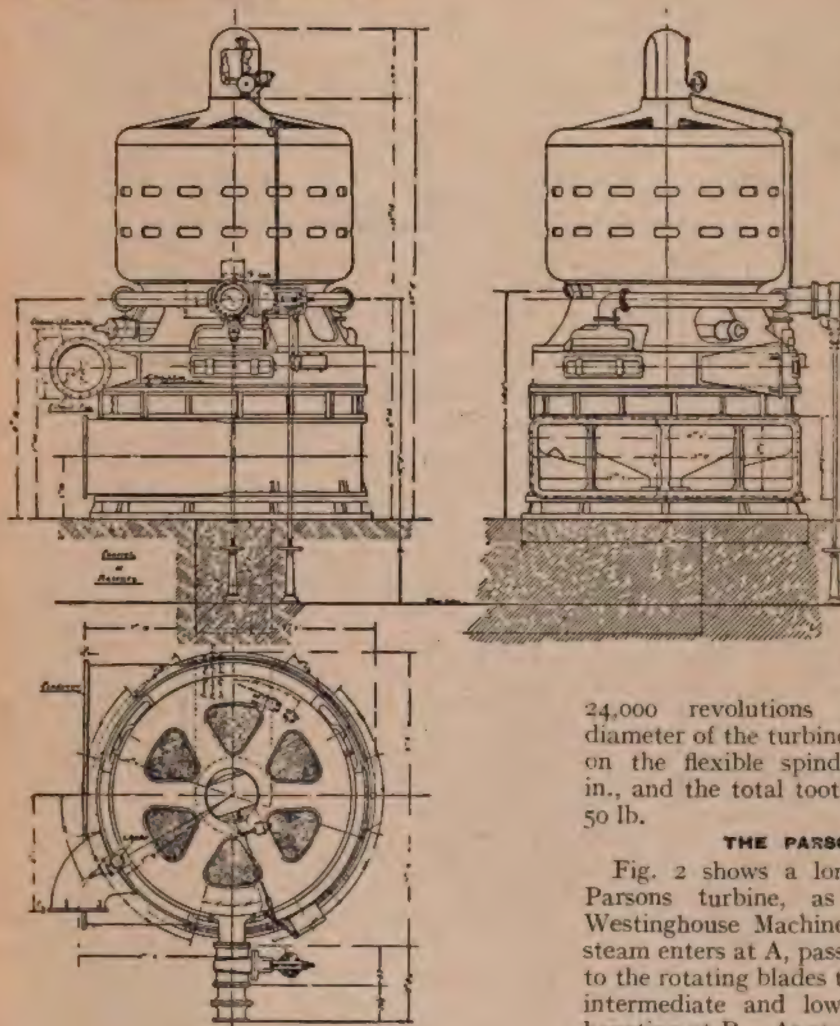


FIG. 3. THE CURTIS TURBINE.

of 1,000 ft. per second being about the limit. The introduction of many rows of moving and stationary vanes at once overcomes this difficulty. The steam loses some of its velocity at each row, and so, on this principle, turbines have been made that run efficiently at speeds not much in excess of those of some high-speed reciprocating engines.

THE DE LAVAL TURBINE.

Fig. 1 shows sectional plan of a De Laval turbine. The steam enters the nozzle from the chamber D, where it is completely expanded, passes through the turbine bucket F to the exhaust chamber G. The important features are the diverging nozzle referred to above, the fact that there may be considerable clearance between the wheel, casing and nozzle, the flexible turbine shaft with its flexible bearing, the turbine wheel, made of forged nickel steel of increasing thickness from the periphery to the centre to resist centrifugal force; above all the high velocity of the turbine wheel, and the gear wheels required to reduce this velocity usually in the ratio of about ten to one. It is interesting to notice in passing some of the forces acting on this turbine. Suppose in a 10-h.p. turbine the speed of the turbine shaft is 24,000 revolutions per minute and the diameter of the turbine wheel 4·8 in., the torque on the flexible spindle will be about 26 lbs. in., and the total tooth pressure approximately 50 lb.

THE PARSONS TURBINE.

Fig. 2 shows a longitudinal section of the Parsons turbine, as manufactured by the Westinghouse Machine Company. In this the steam enters at A, passes through the stationary to the rotating blades through the high pressure, intermediate and low pressure cylinders, exhausting at B. As stated above, because of the many rows of stationary and rotating vanes and the reduction of speed with each pair of vanes, the speed of the Parsons turbine can, by multiplying the vanes, be reduced to almost any amount. The end thrust is counterbalanced by three rotating pistons placed on the turbine shaft. Many of the details of the Parsons turbine are worthy of special study. The method of preventing leak past the balancing piston and the manner of getting the turbine shaft through the case are examples.

THE CURTIS TURBINE.

The Curtis turbine, unlike the two types described, has a vertical shaft in sizes above 500 kilowatts. It is perhaps best described in the maker's own words :—

Each stage or element of the Curtis turbine essentially consists of a group of expanding nozzle sections, which delivers steam to the first of a group of wheels or

TABLE 1.—Trials of a 24 K. W. Parsons Turbo Alternator

Number of Test.	R. P. M.	Pressure at Stop Valve, lbs. per sq. in. Gauge.	Vacuum in Turbine Cylinder Inches of Mercury.	Electric Output K. W.	Consumption of Steam.		Superheat °F.	REMARKS.
					lbs. per hour	lbs. per K.W. per hour.		
1	4990	80	28.8	24.7	712	28.8		Barometer = 30".
2	4630	77	29.0	11.8	400	33.9		
3	4570	74	29.1	5.15	235	45.6		
4	4900	78	26.0	23.8	798	33.5		
5	4780	79	0	19.7	1350	68.5		

TABLE 2.—Trials of a 50 K. W. Parsons Turbo-Alternator for the Blackpool Corporation.

1	5044	126	28.0	52.7	1480	28.0		Barometer = 30"
2	4880	132	28.5	—	320	—		

TABLE 3.—Trials of two 100 K. W. Parsons Turbo-Dynamos (d. c.) for West Bromwich.

1	3500	129	27.8	123	3144	25.5	54	Barometer = 30".
2	3520	134	27.7	122	2913	23.8	64	

rings of buckets. Between the successive rings of buckets rows of stationary buckets, called "intermediates," are placed in the region opposite to the group of nozzles, the function of these intermediates being to reverse the motion of the steam received from one set of moving buckets, and to deliver it against the following set of moving buckets in an effective direction.

The steam from one group of nozzles may thus be passed by the action of successive intermediates through several rows of moving buckets, the number of such rows associated with a single group of nozzles being governed by various mechanical and theoretical conditions. The group of nozzles imparts motion to a column of steam, most of the energy of the steam expansion being transformed into this motion. This motion is then fractionally abstracted by the passage of the steam through the successive rows of moving buckets.

TABLE 4.—Trials of a 500 K.W. Parsons Turbo-Alternator at the Works of the Cambridge Electric Supply Company in January, 1901. Turbine in operation one year. Trials conducted by Prof. Ewing.

Number of Test.	R. P. M.	Pressure at Stop Valve, lbs. per sq. in. Gauge.	Vacuum in Turbine Cylinder. Inches of Mercury.	Electric Output. K.W.	Consumption of Steam.		Superheat. °F.	REMARKS.
					Lbs. per Hour.	Lbs. per K.W. per Hour.		
1	2670	148	25.7	518.0	12,970	25.0		Trials 1 to 5 Barometer 29.93".
2	2741	145	25.4	586.0	14,320	24.4		" A and B " 29.99"
3	2630	151	27.2	273.5	7,730	28.3		Turbine driving its own air and circulating pump.
4	2590	151	27.8	160.5	5,320	33.1		In test by makers, when new, machine showed load
5	2580	121	28.1	0	1,850	—		526.4 K.W. Consumption, 24.1 lbs. steam per K. W. hour.
A	2880	145	25.1	535.0	13,350	25.0		Conditions of steam pressure and vacuum about same as
B	2800	150	26.2	300.0	8,270	27.6		in tests at Cambridge.

TABLE 5.—Trials of a 1000 K.W. Parsons Turbo-Alternator, for Elberfeld Corporation, at the makers' works, in January 1900. Trials conducted by W. H. Lindley, Prof. Schröter, and Prof. Weber.

II.		129	28.2	1190.1	23,067	19.43	18.4	For full particulars of these exhaustive trials see Revue
I.		134	28.5	994.8	20,024	20.15	20.0	de Mécanique, November, 1900.
III.		139	28.4	745.3	165,924	22.31	14.4	
IV.		132	28.5	498.7	126,180	25.20	52.5	
V.		129	28.5	246.5	83,028	33.76	30.6	
VI.		132	28.7	0	40,568	—	24.0	No load alternator excited.
VII.		134	29.0	0	26,026	—	24.3	No load without excitation.

The above-described circle of operations takes place in what is known as one stage of the Curtis steam turbine, and it is generally desirable to use two or more of such stages, in order that the expansive force of steam may be effectually utilised. Where a plurality of stages is used, the turbine conditions are so arranged that all the stages, under normal conditions, will perform approximately equal amounts of work. All the losses and efficiencies of one stage take the form of heat in the steam, and are therefore more or less available as motive force in the succeeding stages.

In our first commercial machines we adopted two such stages, three or four rows of moving buckets being used in each stage. In some of our later machines we have adopted four stages, with two rows of moving buckets in each stage. Under certain other conditions, other numbers of stages and arrangements of buckets will doubtless be adopted.

Parsons turbines have been running in England for over twelve years, a sufficient length of time to permit of some idea being formed as to their durability.

At Newcastle, a Parsons machine ran for thirty-six thousand hours without interrupted service, and at the end of the run there was no perceptible wear on the blades. The oldest Westinghouse-Parsons machine has been running for four years only. The repairs, however, during this time are said to have been light and of a minor character, with no perceptible wear on the blades.

TURBINE PLANTS IN OPERATION.

At the present time there are in England from six hundred to eight hundred turbine plants, either actually installed or sold. These aggregate 200,000 h.p. The largest unit installed is 3,500 h.p. A special feature might be noted here in this connection, that many of the plants in which the first installations were made have added further turbine horse power. On the Continent, Messrs. Brown, Boveri and Co., of Baden, Switzerland, manufacture the Parsons turbine. At the end of 1902 they had sold twenty plants, aggregating 29,000 h.p., the largest unit being 3,000 h.p. On this side of the Atlantic, the Westinghouse Machine Company, of Pittsburg, have made and have in service turbines to the amount of 6,500 kilowatts, while upwards of 5,000 kilowatts more have been shipped. The total turbine power already installed and in process of erection amounts to 110,000 kilowatts. Fifty-seven units will be in operation before the end of the next nine months.

There are unfortunately no figures at hand giving the total horse power of the De Laval turbines installed later than the year 1896, when it was said to be 23,000. Since that time some 13,000 h.p. has been installed in the United States alone.

Recent large contracts for and installation of Parsons and Westinghouse-Parsons turbines include among others the following :—

	Units.	Kilowatts each.
For the Philadelphia Rapid Transit Company, Philadelphia, Pa...	3	5,000
De Beers Consolidated Mines, Kimberley, South Africa ..	2	1,000
Metropolitan District Railway, London (England)	8	5,000
Metropolitan Railway Company, London (England)..	3	3,500
Cleveland, Elyria, and Western Railway, Cleveland, Ohio..	2	1,000
West Penn. Railway and Lighting Company, Pittsburg, Pa. ..	3	1,000
Rapid Transit Subway Construction Company, New York, N.Y. ..	3	1,250
Penn. R.R. Long Island Power House..	3	3,500

For the Metropolitan Railway Company's plant, the turbines are constructed by the Parsons Steam Turbine Company, and are guaranteed to have a combined efficiency of 17 lb. of steam per kilowatt hour, delivered at full load, and 20¼ lb. of steam for each kilowatt hour, delivered at half load, the boiler pressure being 160 lb. per square inch, with the steam superheated 180°F., 90 per cent. vacuum in the condenser.

Recent large contracts for and installations of Curtis turbines include :—

	Units.	Kilowatts each.
Commonwealth Station, Chicago	1	5,000
Lane Cotton Mills, New Orleans	3	500
Fulton Bag and Cotton Mills, Atlanta, Ga.	2	500

In all, 200,000 h.p. of Curtis turbines are said to be under contract.

These figures show that the turbine must now be seriously considered a rival of the reciprocating engine. For, while it is true that in America it is used almost entirely for driving electric machinery, yet in England it has already been employed as a blowing machine (the air compressor being a counterpart of the turbine) for driving centrifugal pumps with high lifts, for ventilating purposes, and for marine work. In these various positions its steady growth is the best indication of its performance; and it need not be restricted to these alone, for it is excellently adapted to other services, where its high speed is not a positive disadvantage.

STEAM TURBINE *v* RECIPROCATING ENGINE.

Comparing the steam turbine with the reciprocating engine, it is seen that the former has the following points of advantage :—The turbine has no valve gear, no vibration, is very light, and requires only sufficient foundations to bear its weight. It is the more simple of the

Table 6.—Trials of a 1,000 K. W. Parsons Turbine driving dynamos for Newcastle & District Electric Lighting Company's Power Station. Trials made by Mr. Hunter, Engineer to Newcastle & District Lighting Company.

No. of Test.	R. P. M.	Press. at Stop Valve lbs. per sq. in. Gauge.	Vacuum in Turbine Cylinder, Inches of mercury.	Electric Output, K. W.	Consumption of Steam.		Superheat °F.	
					lbs., per hr.	lbs. per K. W. per hr.		
1	[illegible]	138	26	1011.6	21,734	21.48	71	Barometer = 30"
2	[illegible]	141	26	909.0	18,610	20.47	86	
3	[illegible]	142	26.3	894.6	17,760	19.85	128	
4	[illegible]	144	26.3	890.7	17,020	19.1	132	
5		144	26.3	882.9	17,171	19.43	135	
6	[illegible]	145	26.3	874.0	16,983	19.42	137	
7		145	26.3	901.1	17,500	19.29	137	
8	[illegible]	146	26.3	896.7	17,302	19.11	136	
9	[illegible]	142	26.4	862.2	16,479	19.15	136	
10		142	26.6	787.2	16,800	18.96	133	
11	[illegible]	146	26.3	944.2	17,03	18.78	131	
12	[illegible]	140	26.3	986.6	18,434	18.52	142	
13	[illegible]	135	26.3	942.5	17,559	18.52	146	
14	[illegible]	135	26.4	942.6	17,460	18.52	182	
15		140	26.5	878.1	15,857	18.06	195	
16	[illegible]	146	26.6	863.3	15,493	17.94	221	
17		145	26.5	897.8	15,922	17.73	237	

two. The torque on the shaft is uniform, and there are no moving parts to be brought to rest and accelerated twice in every revolution. Condensation should be small, and full advantage is taken of low exhaust pressures. With three-cylinder reciprocating engines, on the other hand, about the same results are obtained, with a seventy per cent., eighty per cent. and ninety per cent. vacuum. The turbine is compact. It is impossible to give figures of general application, but it has been calculated that it requires about eighty per cent. of the floor space of the vertical engine of the same power and one-half the engine-room capacity; about forty per cent. of the floor space required by a horizontal engine and a correspondingly smaller amount of engine-room capacity. It is a comparatively simple matter to erect and test at the maker's plant. It is admirably suited for the use of superheated steam. The

Table 7.—Trials of a 10 H. P. De Laval Turbine. Trials conducted by Prof. Goss.

Number of Test.	R.P.M.	Press. at Stop Valve, lbs per sq. in. Gauge.	Vacuum in Condenser, Inches of mercury.	B.H.P.	Consumption of Steam.		Superheat °F.	REMARKS.
					lbs. per hour.	lbs. per B. H. P. per hour.		
1	2138	130	Exhaust at Atm. Press.	0.00	120.8	......	None	Trials 1 to 10 were made with four nozzles in operation.
2	2345	130		1.63	210.3	128.6		
3	2033	130		2.36	230.8	99.8		
4	2118	130		2.97	254.6	85.7		
5	1917	130		3.46	275.5	79.6		
6	2072	130		4.38	313.0	71.5		
7	2228	130		5.10	328.5	64.4		
8	2376	130		7.52	403.0	53.6		
9	2453	130		8.24	422.8	51.3		
10	2411	130		10.33	491.8	47.3		
11	2584	130		0.00	121.4	......		Trials 11 to 14 were made with three nozzles in operation.
12	2312	130		3.95	267.8	67.8		
13	2125	130		4.77	286.0	60.0		
14	2490	130		6.50	346.3	53.3		
15	2346	130		0.00	99.3	......		Trials 15 to 18 were made with two nozzles in operation.
16	2049	130		1.95	162.6	83.4		
17	1909	130		3.43	222.9	65.0		
18	2412	130		3.87	229.6	59.3		

steam consumption is about the same as that of the reciprocating engine when new, but since there are no rubbing parts, the wearing of which causes leakage, this consumption should be approximately constant throughout the life of the turbine. Its consumption varies less than that of the reciprocating engine over wide ranges of loading. No cylinder lubrication is required by the turbine, in consequence of which the exhaust is pure, a matter of considerable importance where water is dear, while difficulties that are unavoidable in extracting the oil are not encountered. Incidentally because of this, less work is required in the boiler room.

The turbine is, because of the uniformity of its driving force, specially suitable as a prime mover for such a system as alternators running in parallel. With it there is no tendency to produce those periodic fluctuations of speed which occur during every revolution of a reciprocating engine. The problem of speed regulation is consequently much simplified. To effect this, it is only necessary to supply a governor, which will keep down fluctuations of speed due to a sudden change of load, prevent surging, and give the drop in speed from no load to full load that is necessary for parallel operation.

It is worthy of notice that all Westinghouse-Parsons turbines installed are running alternators in parallel, and their operation in this connection is guaranteed to be satisfactory.

Looking at the disadvantages, it must be noticed that, with some types of turbines, it is difficult to get the shaft through the case. All, for reasons referred to above, must have excessive speeds that do not permit of belt drives. Where many rows of vanes are used, the clearances must be small, causing expense because of the accurate workmanship required. In the De Laval type, however, the clearances may be very considerable—are, in fact, from two to five millimeters.

COST AND ECONOMY OF TURBINES.

It would be surprising if, for a time, the initial cost of turbines were much below that of reciprocating engines. The experimental work of years undertaken by the producers has undoubtedly involved great expenditure, and it is only right that they should receive remuneration in proportion to the incurred expense and to the risk involved. Speaking generally, the first cost of a turbine and its alternator will not differ much from that of a cross compound Corliss engine with its alternator of good manufacture. When, however, the cost of foundations, engine-room capacity, and floor space is taken into account, any advantage in price is probably with the turbine. The cost of attendance, repairs, oil, etc., should be less in the case of a turbine than of a reciprocating engine.

As regards economy, it will be seen from the accompanying tables of results of trials that the consumption is not much different from that of the best reciprocating engines when running at most efficient loads. At light loads the turbine ought, from its construction, to have an advantage over the reciprocating engine.

EFFECT OF SUPERHEATING.

The turbine is admirably adapted to the use of superheated steam, the smaller fluid friction, due to the use of a rarer gas and the elimination of water, having a marked influence on the economy. Just how great a reduction in the consumption superheating will ultimately effect is not known, but the trials already made to determine this show very satisfactory results.

The best economy recorded in the annexed

Table 8.—Tests on a 300 H. P. De Laval Turbine. Conducted by Wilh. Jacobson.

No. of Test.	R. P. M.	Press at Stop Valve lbs per sq in Gauge.	Vacuum in Turbine Cylinder. Inches of mercury	B. H. P.	Consumption of Steam. lbs. per hr.	Consumption of Steam. lbs. per B. H. P. per hr.	Superheat °F.	REMARKS.
1	754.6	151		342.1	5 270	15.4	20	Installed in a Paper and Cellulose Factory at Pötschmühle, Bohemia.
2	750.0	147		297.8	4,590	15.5	17	
3	760.0	143		252.6	3,960	15.7	20	
4	753.0	147		214.3	3 820	15.5	17	
5	750.0	154		165.0	2,640	16.0	10	
6	762.0	162		120.5	1,988	16.5	4	
7	762.0	162		74.5	1,476	19.8	4	
8	762.0	165		30.8	663	21.5	5	Exhaust at atmospheric pressure.

results of Parsons turbines occurs in the trials of a 1,000 kilowatt machine, built by Messrs. C. A. Parsons and Co. for the Newcastle and District Electric Lighting Company. The trials were conducted by Mr. Hunter, engineer for the Company. The vacuum was 26·5 in., the initial steam pressure 145 lb. per square inch (gauge), and the superheat, 237° F. The lowest consumption recorded, 17·7 lb. of steam per kilowatt hour, is equivalent to 13·2 lb. per e.h.p. per hour, or expressed in b.t.u. is 268 b.t.u. per e.h.p. per minute. Taking the combined efficiency of turbine and dynamos (there were two placed tandemwise), as eighty-three per cent., the calculated consumption of steam per i.h.p. per hour is 11·0 lb. This corresponds to a thermal consumption of 223 b.t.u. per i.h.p. per minute. This same turbine using steam at 138 lb. per square inch initial pressure (gauge), superheated 71° F., with 26 in. vacuum in the condenser, took 21·5 lb. steam per kilowatt hour. This corresponds to 16 lb. per e.h.p. per hour, or 300 b.t.u. per e.h.p. per minute. The advantages of superheating and the higher steam pressure are obvious.

TESTS.[1]

The best results to hand of trials on a Westinghouse-Parsons machine show a consumption of 12·4 lb. of steam per e.h.p. per hour. Taking the efficiency of the combined plant as above, the calculated steam per i.h.p. per hour is approximately 10·3 lb. This corresponds to 246 b.t.u. per e.h.p. per hour. These trials were made on a 1,500 kilowatt machine, with an initial steam pressure of 150 lb. (gauge), 140° F. superheat, and a vacuum of 28 in.

The trials giving this very low consumption were made by the Westinghouse Machine Company, who vouch for their accuracy, and the results are substantiated by three distinct tests.

The trials for the 1,000 kilowatt turbo-alternator, built by Messrs. C. A. Parsons and Co. for the city of Elberfeld, were made by Mr. W. H. Lindley and Professors Schröter and Weber. A complete account of these trials, which were very exhaustive, may be found in the *Revue de Mécanique* for November, 1900. The best consumption recorded — 19·43 lb. per kilowatt per hour—is equivalent to 14·43 lb. per e.h.p. per hour, or, assuming an efficiency of eighty-three per cent. for turbine and alternator, the calculated steam per i.h.p. per hour is 11·8 lb. The steam pressure was 129 lb. per (square) inch (gauge), with 18·4° F. superheat and the vacuum 28·2 in. The consumption expressed in b.t.u. is 270 b.t.u. per e.h.p. per minute and 264 b.t.u. per i.h.p. per minute, a result agreeing very closely with the previous one.

In the trials made by Professor Ewing on the 500 kilowatt Parsons turbo-alternator, at the Cambridge Electric Supply Company's plant, with a steam pressure of 145 lb. per square inch (gauge), vacuum 25·4 in., the consumption was 24·4 lb. per kilowatt per hour, corresponding to 18·2 lb. per e.h.p. per hour, or 274 b.t.u. per e.h.p. per minute. With the same assumption as above, the calculated consumption per i.h.p. per hour is 15·1 lb., corresponding to 225 b.t.u. per i.h.p. per minute. It is to be noted that in these trials the turbine was driving its own air and circulating pumps. The trials were made after the turbine had been in operation for one year. In the maker's tests, when the turbine was not running the air and circulating pumps, the consumption was 24·1 lb. per kilowatt per hour—*i.e.*, practically the same as after one year's operation.

The guaranteed efficiency of the turbines for the Metropolitan Railway Company's plant, referred to above—17 lb. of steam per kilowatt hour—is equivalent to 12·7 lb. per e.h.p. This corresponds to a consumption of about 10·5 lb. per i.h.p. per hour, or 213 b.t.u. per i.h.p. per minute.

There is very little data at hand concerning the economy of the Curtis turbine. A test made by the makers on a 600 kilowatt machine shows a consumption of 19 lb. of steam per kilowatt hour, the initial steam pressure being 140 lb. gauge, the vacuum 28·5 in. and no superheat. This is equivalent to 14·2 lb. per e.h.p. per hour, or, expressed in b.t.u., 269 b.t.u. per e.h.p. per minute.

In trials on a 10 h.p. De Laval turbine at Purdue University by Professor Goss, the best consumption recorded is 47·8 lb. of steam per b.h.p. per hour, corresponding to 805 b.t.u. per b.h.p. per minute. The initial pressure of the steam was 138 lb. per square inch (gauge), and the brake horse-power of the turbine, 10·33.

In a trial on a 50 h.p. De Laval turbine by Professor Cedarblom, of the Royal Polytechnic College at Stockholm, Mr. Andersson, assistant at the Royal Polytechnic College at Stockholm, and Mr. Uhr, Inspector of the Board of Trade, Stockholm, a consumption of 19·78 lb. of steam per b.h.p. per hour was obtained. The initial pressure was 122·3 lb. per square inch (gauge), and the vacuum 26·4 in. The thermal consumption is 352 b.t.u. per b.h.p. per minute.

In trials on a 300 h.p. De Laval turbine by Dean and Main, an average consumption for six trials is recorded of 14 lb. per b.h.p. per hour, corresponding to 272 b.t.u. per b.h.p.

per minute. The initial steam pressure was 207 lb. per square inch (gauge), the vacuum 27·2 in. and the superheat 84° F.

THE FUTURE OF THE TURBINE.

All things considered, it looks as if the steam turbine had made a permanent position for itself as a prime mover, and that it only needs time to extend its sphere of action. Probably the steam engine is the prime mover for nine-tenths of all the power that is developed, and any improvement producing a greater economy in its operation will have a powerful commercial influence. The reciprocating steam engine has apparently nearly reached its limits of economy. Although the turbine is not a perfect heat engine, when those improvements are applied that experience alone can suggest, it will, probably prove itself a more efficient machine than the reciprocating engine, and will mark one more step in the advancement of steam engineering.

There is a wide difference between the heat engines at present in commercial use and the perfect heat engine; and, although the thermal efficiency of the turbine is not as great as some internal combustion engines, the turbine, as it stands to-day, is a very simple and highly efficient steam engine. It is peculiarly adapted to the performance of certain kinds of work, and there is every reason to expect that those bright prospects for the future, which are indicated at present, will be more than realised.

The writer desires to thank the De Laval Steam Turbine Company and the General Electric Company for catalogues and information and especially wishes to express his indebtedness to the Westinghouse Machine Company, who through Mr. Duff, have placed photographs, results of tests and much useful information at his disposal.

Read before the Canadian Society of Civil Engineers.

THE DISINTEGRATION OF THE ATOM.

It is well to proceed slowly in the radium question. The phenomenon of radio-activity has conjured up speculations that go to the very root of our preconceived notions as to the constitution of matter. The list of "elements" that occupied our earliest studies has, of course, received constant additions, but until lately the "atom" may be said to have dominated chemistry. According to the text books it was presumed to be "the least particle of an elementary body that was capable of entering into or being expelled from a compound."

The importance of the atom pales before the electron. According to the theory stated by Sir Oliver Lodge in his lecture at Birmingham, 300,000,000 of atoms could lie side by side in an inch, but to the electrons or small particles of electricity composing the atoms of matter are of such size that 100,000 of them could lie in the diameter of an atom.

We are told that the whole phenomenon of radium is intelligible and simple on the theory that radio-activity is due to atomic disintegration. On the screen was thrown a "portrait" of an atom of matter as nearly as it could be estimated, consisting of positive and negative electricity—the negative electrons in a state of violent movement with occasional possibility of escape. Sir Oliver Lodge remarked that the spontaneous breaking up of an atom constituted a novel source of energy larger than any previously known. The amount of energy of any weighable collection of atoms was enormous if it could be got at, but in practice only a very few atoms were unstable from instant to instant. Most behaved as if they were permanent; but they were probably none of them really and eternally permanent. The discovery of this new or intra-atomic energy affected their estimate of the possible life of the sun, and, to some extent, of the probable geologic age of the earth. But the most important consequence was the discovery of the mutability of matter, the transmutation of elements, and the liability of material atoms to break up or explode. Activity was the rule through the whole world of life, through the solar system and the stellar universe also. Birth, culmination, and decay were the rule, whether it were for a plant or an animal, or for a nation or a planet, or a sun. Nothing material was permanent. Millions and billions, aye, trillions of years it might last, but it was slowly changing, not merely the groupings, but the foundation stones (or atoms) themselves. The atoms were crumbling and decaying; must they not also be forming and coming to the birth? This last they did not know as yet; it was the next thing to be looked for. Decay only, without birth and culmination, could not be the last word. The discovery might not come in their time, but science was rapidly growing, and it might. Science was still in its early infancy; they were beginning to comprehend a few of the secrets of Nature; they were yearly coming nearer to some sort of comprehension of the mind and method infused into the material cosmos. They now knew things which had been hidden from the wise and prudent of all time. Surely somewhere there must be joy at seeing man thus entering into his heritage and realising these primal truths concerning his material environment, whereof he had been living in ignorance all these thousands of years.

The theory propounded by Sir Oliver Lodge opens up a new chapter, or a new *volume* of science, the far-reaching nature of which it is impossible to foresee, but despite the highly-coloured speculations to which the theory has given rise, we think he would be the last to claim that we are within measurable distance of the transmutation of metals.

The prize of 100,000 francs placed at the disposal of the Parisian press syndicate by M. Osiris has been divided between Mme. Curie, to whom 60,000 francs has been allotted, to enable her to continue her researches as to radium, and M. Branly, who received 40,000 francs for his discovery of the conductibility and non-conductibility of filings under the influence of the Hertzian waves, which rendered wireless telegraphy possible.

BUSINESS SYSTEM AND ORGANISATION.

BY

D. N. DUNLOP.

This series of articles is concerned with systems for organising factory labour on an equitable basis. The present instalment deals with accurate time-keeping, and includes some interesting particulars of the calculagraph. By way of illustration, the author has included some suggestive specimen cards. The previous articles were as follows: "The Provision of Labour" (April, 1903), "Stockkeeping and Recording" (August, 1903), "The Perpetual Inventory" (October, 1903). The next subject discussed will be the work of the Record Office.—ED.

IV.—A SYSTEM OF TIME-KEEPING.

THE highest and most successful type of modern industry demands not only the finest mechanical equipment and the most competent labour staff in order to increase the quality and quantity of the output and the money-making capacity of the concern, but also an organisation that will enable the manager to know day by day whether the various departments are working at full efficiency, and whether the calculated profits on the product are real or only imaginary.

It is of vital importance that the manager should keep in touch not only with every part of the concern, but that every detail should be within his grasp; he must be aware of the strong and weak points, so that he may employ all the power, knowledge and experience available to strengthen the mighty machine of production, and enable it to work at an efficiency as near 100 per cent. as possible. The manager must keep his fingers on the pulse of the establishment.

ACCURATE COST-KEEPING *v.* GUESSING.

The first step in this direction is to adopt an accurate system of cost-keeping, but this alone will not suffice, unless the labour be thoroughly organised and supervised.

A flexible, accurate system of factory accounting is an exact science, and will show the details of gains and losses on the various products. A thorough system of factory records will provide, in addition, unerring indications of the exact working conditions and efficiency of all departments of the factory and office, which will enable the factory manager to check large unnecessary expenditures or heavy losses.

The man who does not know what the labour of his manufactured product costs him is reduced to guessing.

Most factory managers keep a careful record of the cost of material entering into the goods they produce; many have appliances of some kind for recording the time at which each employee enters and leaves the works; from his accountant he can usually ascertain the total amount of the output for the same period, and thus the average cost of labour may be computed.

But when inquiry is made as to the exact amount and value of every different kind of labour that is expended on any given job or operation, the usual practice is to estimate it. By tolerating such practice a large manufacturing business becomes nothing more or less than a huge speculation, having no reliable evidence of profit or loss until the annual inventory and balancing of accounts comes as a shock or a pleasant surprise. By means of a proper system of factory accounts and records, as soon as a piece of work is completed, evidence of its cost is forthcoming which enables the selling price to be fixed no longer as a speculation, but intelligently and wittingly.

As an instance may be quoted the experience of the general manager of a well-known and prosperous firm in America: "Owing to my plant having work to its full capacity, I recently farmed out a large order to another firm, agreeing to pay them for all especial tools necessary to be made, provided they gave me a price on the tools. They made the price at $154, after a day's discussing with their tool-makers, and informed me after the completion of the contract *that they must have lost heavily on the special outfit they made*. I did not doubt their statement, as our clock recorder had shown that our special jigs and fixtures, similar in every way, cost $268·67 for material and labour alone." The other manufacturer did not use a cost-keeping system; he only estimated the cost of production.

CLERICAL WORK SHOULD BE REDUCED TO A MINIMUM.

Labour, unless properly organised, is at the root of most of the difficulties and failures which make the factory manager's life a burden to him. In considering labour, we treat mainly of work, time and pay.

The chief consideration in organising factory labour is to eliminate all clerical work if possible from the factory departments, and certainly from the workman's duties. The workman is proverbially a "bad hand" at writing, and makes a trouble of it nine times out of ten; it takes him three or four times as long as it would any of the clerks or even the foreman.

The number of minutes thus wasted in a year in large factories by the workmen under the old system, and paid for and charged as productive labour, although there is no output during the time, would pay the salary of an extra clerk who would do all the workmen's clerical work and a great deal besides, leaving the men free to increase the output. The personal factor involved in carrying out any cost system may make or wreck its success, for the *human equation* is at times a source of grave inaccuracy. Whenever, therefore, it is possible to eliminate brain work and substitute machines which make no clerical errors, whenever by pulling a lever a correct result may be obtained where formerly an expensive and fallible clerk was required to make mathematical calculations, a decided advance has been made towards perfection of system.

Under the old system each employee was provided with a board on which he entered the nature of his work, the number of the order, and the time spent thereon. Suppose the workman has been employed on a dozen different jobs during the day if, as is usually the case, he makes up his time board at night, how can it be reasonably expected that he will remember how long he operated on each article. Again, the check, or token, system of time-keeping at the gate of the factory having but one entrance, and the different shops scattered about over acres of ground is a great disadvantage and loss to the employer. Some of the shops in large works are as much as five minutes' walk from the gate which means that every man

from that shop wastes twenty minutes every day between the gate and his work, which in a year means at least 15s. per man, or £75 for a hundred men; moreover, a workman once within the gates with his check or board in his pocket does not always walk briskly or go straight to his work.

How is this leakage to be stopped?

TIME RECORDERS.

It is clearly in the interest of the employer to install a system which shall be accurate, and the knowledge that his time is being recorded automatically against him sharpens the workman up and prevents his falling into lazy inefficient ways. The British workman is in the main conservative, and difficulty is often experienced in making him adopt and carry out new rules and regulations, or new systems in the workshops. The use of mechanical time recorders, however, has rarely raised any spirit of opposition among the employees, who can check its accuracy every time they use it, and know that its records ensure their being paid for every minute registered "in." Unless the works are small and compactly built, so that the gate is close to all parts of the building, a time recorder should be placed at the entrance to each shop. There is no fear that the workman will fear to register, or dawdle when inside the gates, for he soon gets to understand that upon these records only will the pay-roll be made out.

The recorder consists of an eight-day clock with a large clear dial, and contains mechanism for marking on the card slipped into the slot, the exact time in figures at which the lever was pulled. The best plan, it has been found, is to provide two time cards per man for each week, one ruled, for Monday, Wednesday, and Friday, the second for Tuesday, Thursday, and Saturday, so that the cost department or record office can post up the cards the next day. These cards are kept in racks at the side of the recorder, one rack for "in," and another for "out." When he enters the shop on Monday morning, the workman takes the card bearing his number from the rack, inserts it in the slot, pulls a lever, and when the card drops into the receptacle, he sees that the time stamped on it corresponds with the correct time on the dial; then he places the card in the "in" rack, and goes to the foreman to receive his work. When the men have passed out at night, the cards are collected by the time clerk, who also distributes the cards for the following day in the rack. It is thus possible at any time during the day to ascertain from the racks which workmen are in and which absent.

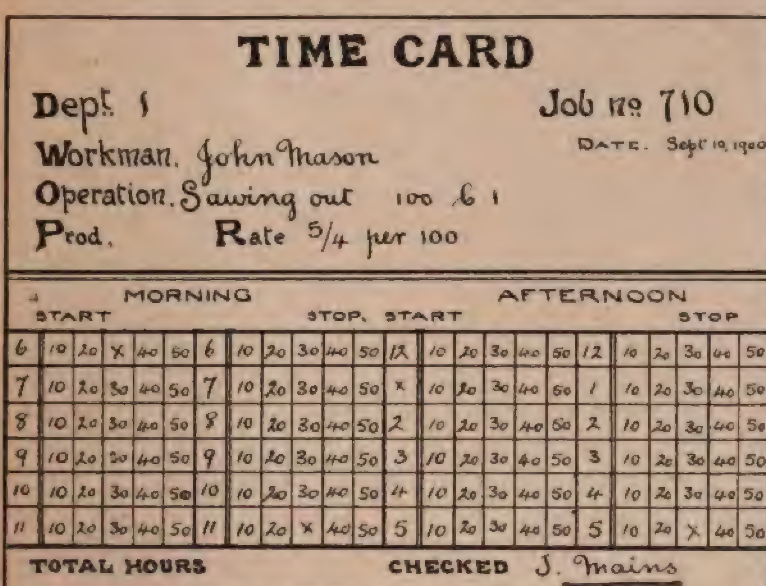
Many firms use a time recorder in all the shops for recording the exact time spent on a job by the workman (fig. 1). The most prolific source of error is doubtless in the method of recording time—time being the important element in computing the cost of labour. So well is the difficulty understood of obtaining exactness in the clerical record made in the old-fashioned way, when the workman is allowed to write down the time he spends on each job or operation, that many managers have detailed time-keepers to visit the individual employees frequently and regularly for the collection of such data. Experience, however, shows that the average clerk even does not accurately record elapsed time by means of pencil and clock dial, nor does he always rightly subtract time of day from time of day when posting up time recorder cards, and there is the added danger that when looking over a card containing times of commencing and times of stopping work, he may mix the records and subtract the wrong finishing time.

THE CALCULAGRAPH AND ITS FUNCTIONS.

The manufacturers who devised the calculagraph have made a great advance on all other systems of time recording. The ingenious calculagraph saves 50 per cent. or more of the time clerk's work by registering the time at which the job commenced, and mechanically subtracting this from the time of finishing; the difference or time elapsed is then printed in hours and minutes on the card dropped into the slot.

The calculagraph makes no clerical errors, and can be manipulated by anyone. It is only necessary to push a card into the slot and pull a lever, and the number of calculations this clever machine can make is only limited by the number of cards it is possible to push consecutively into the slot during a given time. A test recently made of a thousand calculations made by clerks of elapsed time, covering the work of 18 different time-keepers, showed that more than 20 per cent. of the records contained errors—some of them exceeding one hour. These tests were made by experts using stop watches; the calculagraph therefore will obviate the chance of any such errors. It may be had with or without a dial marking the time of day.

The ruling of the cards need not be exactly as illustrated here; this is merely an example of the kind of record made.


TIME CARD

Dept. 1 Job no. 710

Workman. John Mason DATE. Sept 10, 1900

Operation. Sawing out 100 6 1

Prod. Rate 5/4 per 100

MORNING AFTERNOON

START STOP. START STOP

6	10	20	X	40	50	6	10	20	30	40	50	1X	10	20	30	40	50	12	10	20	30	40	50
7	10	20	30	40	50	7	10	20	30	40	50	x	10	20	30	40	50	1	10	20	30	40	50
8	10	20	30	40	50	8	10	20	30	40	50	2	10	20	30	40	50	2	10	20	30	40	50
9	10	20	30	40	50	9	10	20	30	40	50	3	10	20	30	40	50	3	10	20	30	40	50
10	10	20	30	40	50	10	10	20	30	40	50	4	10	20	30	40	50	4	10	20	30	40	50
11	10	20	30	40	50	11	10	20	X	40	50	5	10	20	30	40	50	5	10	20	X	40	50

TOTAL HOURS CHECKED J. Mains

FIG. 1. JOB TIME CARD.
Old system with hand labour.

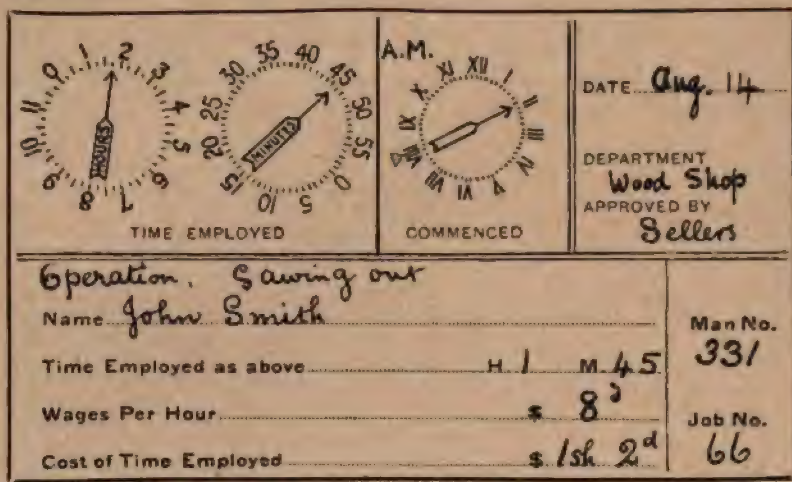


FIG. 2. TIME CARD.

Calculagraph system of mechanical recording.

The card (fig. 2) shows a specimen of the records made by a calculagraph. We find that John Smith, of the wood shop, began work on job 66 at 8.10 a.m. and was employed 1 hour and 45 minutes, which at the rate of 8d. an hour, the cost clerk computes at 1s. 2d. Each workman who operates on job 66 will receive a similar card in his own department, and if he be employed more than one day upon it, there may be several cards bearing his name or number.

It will be the duty of the foreman or his clerk to make out and issue these cards, and upon their return to forward them, after filling in the rate per hour, to the cost department of the record office. Meanwhile the stock-keeper has issued his card showing the stock or stores issued in connection with this order; when the job is completed the totals of labour costs in each department of the factory will be handled by the record office and charged to those departments. From the cards which reach the office the prime cost of the article manufactured will be computed by adding the proper percentages for factory expenses and general expenses, and from the manufacturing cost the selling price will be duly fixed by the manager and filed in a special catalogue cabinet.

The calculagraph may also be employed to keep a check on piece workers by registering the time spent on each job and providing data for fixing and maintaining a fair rate of pay. If a workman be granted leave of absence during business hours for any reason the calculagraph will show how long he is away. It may also be used in the absence of other time recorders, to record the workmen's daily attendance time, but for that purpose the time recorder is to be preferred, the great value of the calculagraph being found in the keeping of labour costs, where the accurate time employed in producing any article of manufacture affects not only the pay roll, but the selling price and profit made by the firm.

Special calculagraphs can also be had for industries or factories where the rate of pay per hour is uniform in the department, which print the value of the elapsed time in £ s. d. or other coinage. The calculagraph, therefore, obviates all necessity for clerical work on the part of the workman, besides saving half that of the time clerk. The production or cost cards supplied to the workman with all necessary data filled in either by the foreman's clerk or in some factories by the record office or cost department which is the better plan, are taken by him to the calculagraph to register when he commences a job and again when it is finished; he then gives up his card to the foreman, who checks it, and forwards it to the record office. The calculagraph thus does for him with absolute accuracy what two-thirds of the time he would but guess at. If the workman has given his employer the full value of the time for which he is paid, the calculagraph records or job cards for the day under his name and number, when totalled must exactly agree with the time on his attendance time card for the same day.

Another mechanical recorder, the "Dey" Time Register, recently further improved by the inventors, is entirely of British manufacture and possesses some distinctive features, the value of which many managers will appreciate.

(1) The workman never has access at any time to the records of the register, for there are no cards to be dropped into the slot as in the case of the Calculagraph and Rochester Recorder; but the men can see the record sheet through the plate-glass doors at the side, and check its accuracy. The "Dey" registers directly in bold type on a combined "Times and Wages Sheet" the exact time of the men's ingoings and outgoings, ready to be totalled and extended in the £ s. d. columns by the pay clerk at the end of the week.

(2) The "Dey" Time Register now makes a special feature of reproducing a facsimile of any works' time and wages sheets by combining the two ready for use on the register.

(3) By registering directly on the combined times and wages sheet, the various time and wages books or cards are dispensed with, and the pay clerk pays from the original sheet, on which each man has registered his own time—there can, therefore, be no dispute.

(4) By means of a clever attachment to the "Dey" the men can, in addition, record on cards for the cost department or record office, by means of the same machine, the time when they start and finish a job.

In appearance the "Dey" Time Register is compact, and the mechanism is wonderfully simple. It consists of a clock specially designed for the purpose and of a dial indicating the days of the week, encircling which is a broad metal band, perforated by numerous holes corresponding with the numbers of the different employees (who may number from 50 to 200, according to the size of the "Dey" selected). All the workman has to do is to push the pointer, fixed by a pivot to the centre of the instrument, into a hole opposite his number on the metal band; the exact minute is instantly printed on a paper sheet attached to a revolving drum inside the machine, and a bell rings to indicate that the time has been duly recorded.

The ribbon which inks the type wheels is fed automatically, winding and unwinding by itself, and only requiring attention about once a year. No matter in what order the employees come in, or go out, the numbers are bound to appear in consecutive order on the time sheet. Another considerable advantage

possessed by the "Dey," is that the time sheet is ready for the cashier to pay wages from, when it leaves the machine, without any transfer to other books; if desired a slip can be pasted in the wages book direct, a great saving of clerical work is thus effected. The record can be examined at any time through plate-glass doors at the side of the machine, and the presence or absence of any employee ascertained at a glance without moving the time sheet.

TESTING THE EFFICIENCY OF THE FOREMAN.

The calculagraph records not only place a check on waste of time by the workman, but form a severe test of the foreman's efficiency. There can be but one reason as a rule for any gaps in the workman's time, *i.e.*, the foreman had not prepared the next job for him before he registered "out" on the last; the foreman should deliver the fresh work and job card to the workman, see that he registers "out" and again "in" on the fresh card, and then O.K. his card. The foreman who allows no gaps is a valuable asset to the firm, and one of the most prominent factors when the cost cards are balanced every week or month because he places the workmen under his charge in a position where they can develop their full mechanical power in production that earns profits for the factory.

If any time be lost between the jobs, the time or cost clerk figures this out, and enters it on the workman's attendance time card (see fig. 2.)

The job card or time card (fig. 1) shows one of the best of the modern systems of registering labour without mechanical recorders, in which the workman's clerical work is reduced to a minimum. All he had to do was to read the time correctly by the factory clock, find the right time column, and cross through the numbers showing the time at which he commenced and stopped operation.

One of the chief benefits of the modern factory systems using cards exclusively for all records and accounts is that as all the cards are balanced daily, any discrepancy in time can at once be located, inquired into and explained; the shortages in time are then charged to the proper account instead of being padded out at the end of the fiscal year and charged to profit and loss, or to non-productive labour.

SELLING MACHINERY ON THE RAND.

We insert the following indictment for what it is worth, and shall welcome expressions of opinion thereon from South African readers.—ED.

THE writer of an article which appeared recently in PAGE'S MAGAZINE emphasised the importance of the commercial side of engineering. The advantage of being a "commercial engineer" is still more apparent in South Africa, judging from the remarks of Mr. C. B. Pattrick, Government Inspector of Machinery for the Krugersdorp district, which were included as an appendix to Mr. Henry Birchenough's report.

It is remarked that while the British salesman is *either* an engineer or a business man, the American is *both*. The business instinct of the American manufacturer suggests to him the advisability of sending a man with the dual experience, the result being that he has only one man to pay, and every intending purchaser is much better satisfied because he can do all his business with one man instead of having to talk engineering technicalities with one and importing details with another. The extreme stiffness and rigid politeness of the British business man is not practised here, says Mr. Pattrick, but there is more warmth and geniality, and if a salesman wants to push business he must leave this smug respectability at home.

The American, like the Colonial, belongs to a new country, where independence of thought, self-reliance, and prompt decision are much more necessary than in an old country; these are traits which, apart from their special business training, make for success. The British system of training engineers is not complete. A pupil goes through the shops and afterwards into the drawing office, sandwiching in some theoretical schoolwork somewhere and is then turned out as an engineer and expected to make his living in the world. He may be an engineer pure and simple, and when more experienced he might do for a professor. This sort of man is occasionally useful, but what is wanted to advance the prosperity of the country is "commercial engineers," *i.e.*, those who, after studying engineering, have gone through a good general course of commercial work and afterwards returned to the engineering world or combined the two.

In England the idea of specialisation is overdone, the result being that each man gets into a rut from which he cannot extricate himself. The majority of commercial engineers one meets are men who, when their pupilage was finished, had never seen a specification and scarcely knew how to copy a letter; their commercial knowledge was picked up promiscuously afterwards, and the result is that the Old Country does not take the position she should because she has no class from which to draw competent technical salesmen.

Mr. Pattrick classes the British agent as a "brusque, blunt honest John sort of a fellow," while the American agent is "a genial and keenly diplomatic business man."

You leave the British agent with business only in your head and wondering if you have done right, whether he has not come out best. You leave the American agent scarcely realising you have been discussing business, with a warm feeling towards him, having had your pill so judiciously sugared that you scarcely realise that you have been taking medicine, and most probably prefer sugared tabloids to nauseous draughts.

A few details are mentioned which help the American to score, apart from any outside assistance. The most important point is that the Americans are experts in standardising, and the very simplest job is done by gauge.

The Depreciation of Factories, Mines, and Industrial Undertakings, and their Valuation.

By the Editor.

ALTHOUGH the subject of depreciation becomes every year more important and varied, it is a matter of regret that there is still no treatise on the subject by a professional accountant accustomed to deal with such affairs. Mr. Ewing Matheson is well advised in bringing out a third and much revised edition of his excellent handbook, which very creditably fills the gap.

Those interested in the question of municipal trading *versus* private enterprise would do well to study the author's remarks upon the subject of municipal depreciation, which grips one of the points often missed in this controversy. It is sometimes urged that as municipal works are generally maintained out of the rates, there is no need to write down their value or accumulate funds for their renewal. It is, however, well known that no mere system of maintenance will provide for that wasting of assets which takes place from many causes or contingencies. The system of municipal accounts generally requires to be placed upon a much sounder basis before it will be possible to state with certainty the exact position of a given undertaking, and in our opinion too little is often allowed for depreciation and sinking fund charges.

SHOULD ADVERTISING BE CHARGED TO CURRENT REVENUE OR CAPITAL ACCOUNT.

In travelling about the country we hear of many different methods of treating the expenses incurred in advertising at the year end, and we believe the general rule to be, to charge all such outlay to the revenue of the year in which it occurs. Such a prudent and thrifty principle, however, needs some qualification, as the author explains :—

Advertising is hardly ever successful unless it is persistent, and it is a mistake to attribute results in any period to concurrent expenditure. From this point of view it would appear fair to charge some of the outlay to capital. To do this directly might be a dangerous course, as the advantageous effect of past outlay may at any time be diluted and speedily terminated by relaxing or discontinuing such expenditure. That is to say, as there is no tangible asset, it would be imprudent and unsound, unless with special safeguards, to divide as profit the increased income shown by charging forward some of the advertising outlay.

But as advertising has been well compared to the sowing of seed for future benefit, the effect will survive for a while after the advertising is stopped. On this principle some firms charge two-thirds of their expenditure to a suspense account, which is written off in two subsequent years. When once this system has been applied for two years, the total annual charge is as though all current expenditure were charged to the revenue of the year in which it occurs, but there is always two-thirds of a year's outlay standing in the books as an asset to be paid for by new partners or shareholders who will reap the benefit of it. On this plan, if at any time the advertising ceases the asset is written off in two years, and the newcomer pays nothing for it, unless, indeed, the goodwill is still deemed to be enhanced by the past expenditure.

THE DEPRECIATION OF ELECTRICAL PLANT.

One of the most interesting portions of the book is the new section dealing with the depreciation of electrical plant. Those who have embarked capital in electrical plant with their own or other's past experience to guide them, have been assured by the sanguine inventor or engineer that finality has at last been reached, and that in regard to renewals or depreciation nothing need be considered beyond the mere physical wear and tear which attend all kinds of plant or machinery. As we all know, however, plant has sometimes to be abandoned, which is still in working order, but will fetch little when sold. It is obvious that, for some time to come, alterations and improvements will become unavoidable if the highest standard of efficiency is to be maintained, and it is now generally recognised that provision should be made for modernising the plant by some form of reserve. For a thorough discussion of the subject we must refer our readers to the book itself. Mr. Matheson's careful methods for fixing the rate of depreciation are well illustrated in the following paragraph :—

An electric-lighting plant working an average of four hours per day is obviously not so highly strained as a factory-power plant working nine hours, or a tramway working eighteen hours a day. There are even some installations, both for public supply and for certain manufacturing purposes, where the machinery is worked continuously. Other operations, such as intermittent pumping in mines, may be confined entirely to night work if the power may be thereby cheapened. If it is desired to maintain a value in the books of account equal to the real value, a depreciation rate of 10 per cent. on the diminishing value would not be excessive, assuming, of course, that all

expenditure for minor renewals are defrayed out of revenue. Such a rate may, at any rate, be applied for the first few years till the efficiency of the machinery has been proved, and the likelihood of coming changes more easily estimated. The rate may then be reviewed and amended, but evidence should first be sought as to whether similar machinery has proved saleable after fifteen years' working at more than one-fifth of its original cost. If the actual sale of some of the plant in order to make room for a better kind is held in view, let the probabilities of selling a dynamo generator be considered, and the price which a user or dealer would pay for it. Experience up to 1903 showed that second-hand electrical machinery ten years old has seldom a saleable value except as scrap, although if left undisturbed it may last longer in its original place.

VALUATION.

In the second portion of the book the author has succeeded in bringing together upon the subject of valuation a large amount of practical information which is not generally available. The modern tendency towards large works in which labour-saving processes are extensively adopted, increases the amount of capital required for profitable working, and in valuing a works for a newcomer the past policy in regard to the purchase of plant is generally reviewed.

We regret we have only room for one extract:—

Labour-saving plant affording great advantages when in use is remunerative or otherwise according to the frequency of its employment. As examples, in an ironworks or factory a slow hand-crane in constant work may be a cause of daily loss not only in wages and repairs, but in waste of time. If such a crane be scrapped or sold for £50, and a new quick-moving crane worked by power installed at a cost of £500, the outlay may be entirely recouped in two or three years. If, after a few years' working, trade becomes dull, and the earning of interest on capital difficult, it would be unfair to treat as a burden the past outlay on the crane without taking credit for the savings already effected, the profit so earned, and for the permanent saving in time which, even in dull periods of trade, its use allows. Excessive timidity in anticipating adverse conditions would hinder all enterprise. If the past savings, instead of having been divided as profit, have been partly applied to a liberal system of depreciation, the permanent benefit of the outlay remains, while the capital has been written off. The value may prove to be permanent and should be paid for by a newcomer.

As a contrary exampl.., a large or special machine showing great economy when at work may be so seldom required as not by its occasional savings to pay interest on the capital outlay, and a proper rate of depreciation. In this cases it would really have been better to retain an old and slower machine. As an extreme example, if an operation of lifting a very heavy weight occurs only once in five years, it may be cheaper to erect a pair of shear-legs on each occasion, even though the operation itself is much more costly than with a properly equipped crane. In short, while on the one hand it would be fallacious and unfair to judge all capital outlay by the measure of dull times, on the other hand, costly appliances may, as above described, sometimes prove a cause of loss rather than of gain. For instance, a factory may be constructed with an output capacity of one ton of product per week for each £100 invested, as compared with existing and smaller factories which have cost £120 per unit of output. Moreover, the labour in the new factory may be only £3 per ton of finished product as compared with £3 10s. in the older factories. But it is possible that this low cost can only be maintained when the factory is in full work, and that when it is only employed at one-half or one-third of its capacity, the proportions may be altered. The expensive labour-saving machinery must remain as a burden which cannot well be got rid of, while workmen may be discharged in the smaller factory. Factories so established may eventually repay those who can afford to wait, but without a large trade the burden of capital, especially if some of it be borrowed, is a frequent cause of failure. Ultimately, the profit is reaped by those who take advantage of the failure to buy the factory for much less than it has cost; and instances occur of a second or even a third change of ownership before the capital can be brought down to a sum on which the earnings will allow a profit.

Notable features of the book are the system of marginal notes and cross references, which we would like to see more generally adopted in other works of this kind, and the excellent graphic charts and tables.

"The Depreciation of Factories, Mines, and Industrial Undertakings, and their Valuation." By Ewing Matheson, M.Inst.C.E. Third Edition. E. and F. N. Spon (London). Spon and Chamberlain (New York). 7s. 6d. net.

NOTES AND NEWS.

THE Council of the Institution of Civil Engineers have nominated their President, Sir William Henry White, K.C.B., F.R.S., to fill the place of the late Sir Frederick Bramwell, Bart., as one of the representatives of that institution on the Engineering Standards Committee.

We are informed that Mr. Robert Mitchell, formerly Demonstrator in the Physical Laboratory of the Royal College of Science, South Kensington, and latterly with Sir George Bullough, of Messrs. Howard and Bullough, of Accrington, has joined the Directorate of the Phœnix Dynamo Manufacturing Company, Ltd., Bradford.

On Christmas Eve, Mr. Jardine, of Nottingham, together with Mrs. Jardine, entertained in the Meadows Hall over 1,400 of the children of the workpeople employed in Mr. Jardine's various factories.

An excellent programme was arranged, many of the items, such as songs, dances and recitations, being contributed by children of the workpeople, and over £100 was distributed in awards. This is the twentieth year in succession in which Mr. and Mrs. Jardine have entertained their workpeople's children.

The lightships at the Goodwin Sands are shortly to be equipped with wireless telegraph apparatus, placing them in communication with the Admiralty station near the Shakespeare Cliff at Dover.

The Lodge-Muirhead system of wireless telegraphy has been the subject of some exhaustive experiments by the War Office during the past six months, and the results obtained are said to have fully satisfied the Government experts.

The electrification of the Lancashire and Yorkshire Railway between Liverpool and Southport is proceeding apace. The original scheme has been somewhat extended, and nearly twenty-three miles of double line have been rendered available for electric traction.

The Great Central Railway Company has decided to follow the example of the London and South-Western and to signal its main lines by the low-pressure pneumatic system combined with electric track circuit. The work is to be begun at the Manchester end, where the traffic is heaviest, and the first installation is to extend from Ardwick Junction, near Manchester, to Newton Station, a distance of about six miles, for the greater part of which there are four lines of rails, besides numerous junctions and sidings.

Junior Engineering Society.

During the month an interesting visit was paid by members of the above society to the Stratton Drainage Works of the Highworth Rural District Council. The party were met by Mr. R. H. Buckley, the resident engineer (of the firm of Messrs. Beesley, Son and Nichols, engineers), who conducted them over the farm, and fully explained the process. Twelve filter beds are employed, and are arranged in two rows, the first and higher row being filled to a depth of two feet with coarse clinker, and the lower row having finer filling. The walls of the beds are of earth and clay puddlings. An upper bed, after standing filled for all twelve hours, is emptied into the lower one adjacent to it, agricultural pipes being laid on the bottom to carry the effluent off. The beds are left dry for about twelve hours after each filling to aeriate. From the lower beds it is drawn off, and flows along a trough, overflowing from this on to the soil. The whole process is effected by gravitation, and is designed by Mr. Dibden (late chemist to the L.C.C.). Mr. W. B. Winchcombe, of Wroughton Road, Swindon, is the contractor, and when completed (in two or three months' time), it is anticipated that this plant will be one of the best put down for the disposal of sewage.

At an ordinary meeting of the society an excellent paper on "Internal Combustion Engines" was contributed by Mr. B. Humphrey, A.M.Inst.C.E.

Eclipse Glazing.

Messrs. Mellowes and Co., Ltd., of Sheffield and London, have in hand the orders for the glazing on their imperishable "Eclipse" system the roofs of the following buildings :—

New Midland Station, Sheffield ; three sub-stations for the Underground Electric Railways, London ; erecting shop, Messrs. Marshall, Sons, and Co., Ltd., Gainsborough; Heysham Harbour Goods Shed, Midland Railway ; Covent Garden Foreign Flower Market; Central Station Extensions, Glasgow ; new fitting shop for Messrs. Head Wrightson and Co., Thornaby-on-Tees ; new shops, Metropolitan Railway and Carriage Company, Ltd., Birmingham ; new shops, Messrs. Greening and Sons, Warrington ; Queen's Road car sheds, Sheffield Corporation ; Woodford Station, Great Central Railway ; extensions, British Westinghouse Company, Ltd., Manchester.

Bath Tramways.

The British Westinghouse Company have just done some quick work in connection with the above. On May 1st last ground was broken for the generating station, car sheds, and office buildings ; and these have since been erected and equipped throughout. The generating station has a capacity of 675 kilowatts, and the car sheds hold forty cars. The complete electrical equipments for the latter consists of Westinghouse 49 B-90, with Westinghouse magnetic brakes. The Board of Trade inspection took place on Saturday, December 12th, that is to say, 7½ months after the commencement of the work.

Third Rail Dangers.

Concerning the operation of elevated trains by electricity, Mr. George Westinghouse is of opinion that there will be a complete revulsion of feeling in the electrical profession as to the necessity for the third rail. He points out that third rail danger may be entirely obviated by resorting to the use of overhead conductors, for which the elevated structure is peculiarly suited. It may seem to be heresy, says Mr. Westinghouse, to advocate the use of the overhead wire, but I venture to predict that there will be a complete revulsion of feeling on this point. When I speak of an overhead wire, I do not mean the slight construction which has prevailed, and the breaking down of which has occasioned trouble, but a substantial engineering arrangement so erected that it would, in fact, not be an offence to the eye.

THE NEW ADMIRALTY WORKS AT DOVER.

A British Naval Station of the Future.

THE RECLAMATION AND EASTERN ARM.

BY

A NAVAL CORRESPONDENT.

THE accompanying photographs, which we are able to reproduce by the courtesy of the Admiralty Works Loan Department, give an excellent idea of the progress which is being made with the scheme which is to provide Dover with a magnificent harbour of 610 acres, thus creating a new naval station on the south coast.

At this point, so important both from strategical and commercial reasons, the sea is often seen at its worst, and perhaps on no occasion has it put the work of the engineer to a severer test than during the great storm of September 10th last, when, although no damage was caused to the permanent works, an isolated temporary stage erected seaward of the east arm was completely demolished.

LONG CONTEMPLATED IMPROVEMENTS.

The accompanying plan will give a better idea of the scheme than a long description. The necessity for an enclosed harbour at Dover has been discussed ever since the appointment of a Royal Commission in 1840, to survey the harbours on the south-east coast, but the idea remained in a more or less nebulous condition until 1895, when Messrs. Coode, Son and Matthews were instructed to prepare plans for the present scheme.

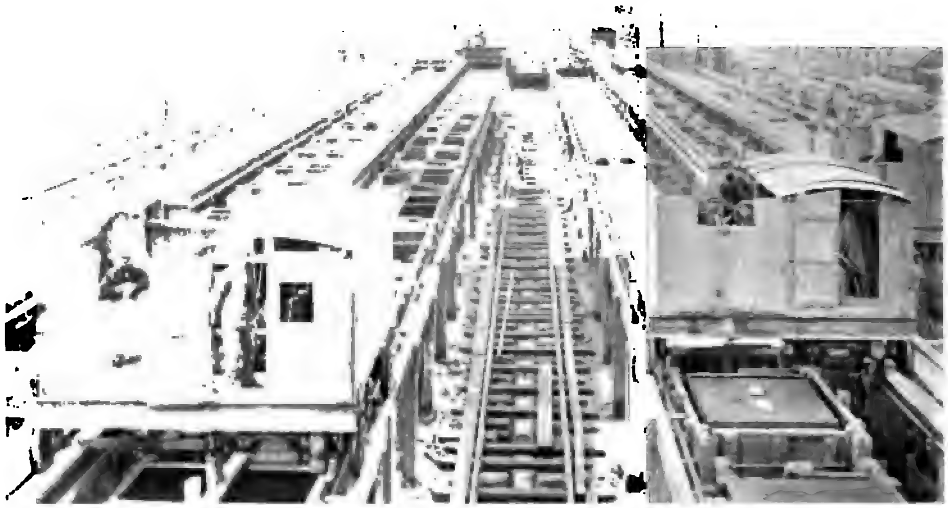
THE PRESENT SCHEME.

Their recommendations involve (1) the extension of the Admiralty Pier, completed in 1871, for a distance of 2,000 ft. in an east-south-easterly direction, thus practically doubling its length. (2) The construction of an eastern arm commencing a few hundred feet beyond the eastern boundary wall of the convict prison, and running in a direction approximately south by west for a distance of 3,320 ft. (3) An isolated breakwater, 4,200 ft. in length, running generally west by south, and east by north, but turning towards the north at its eastern end, and forming the southern protecting arm.

The contract for this scheme was let in 1897 to Messrs. S. Pearson and Son, and the works are being executed under the direction of Major Sir Henry Pilkington, K.C.B., R.E., the Civil Engineer-in-Chief, and Messrs. Coode, Son and Matthews, as chief engineers.

PROGRESS OF THE WORK.

At the present time the Admiralty Pier Extension and east arm are practically completed, and the detached breakwater will be commenced as soon as the temporary stage has been sufficiently extended.



WORKYARD FORMED ON THE SITE OF THE RECLAMATION.
Here all the concrete blocks are prepared for the east side of the works.

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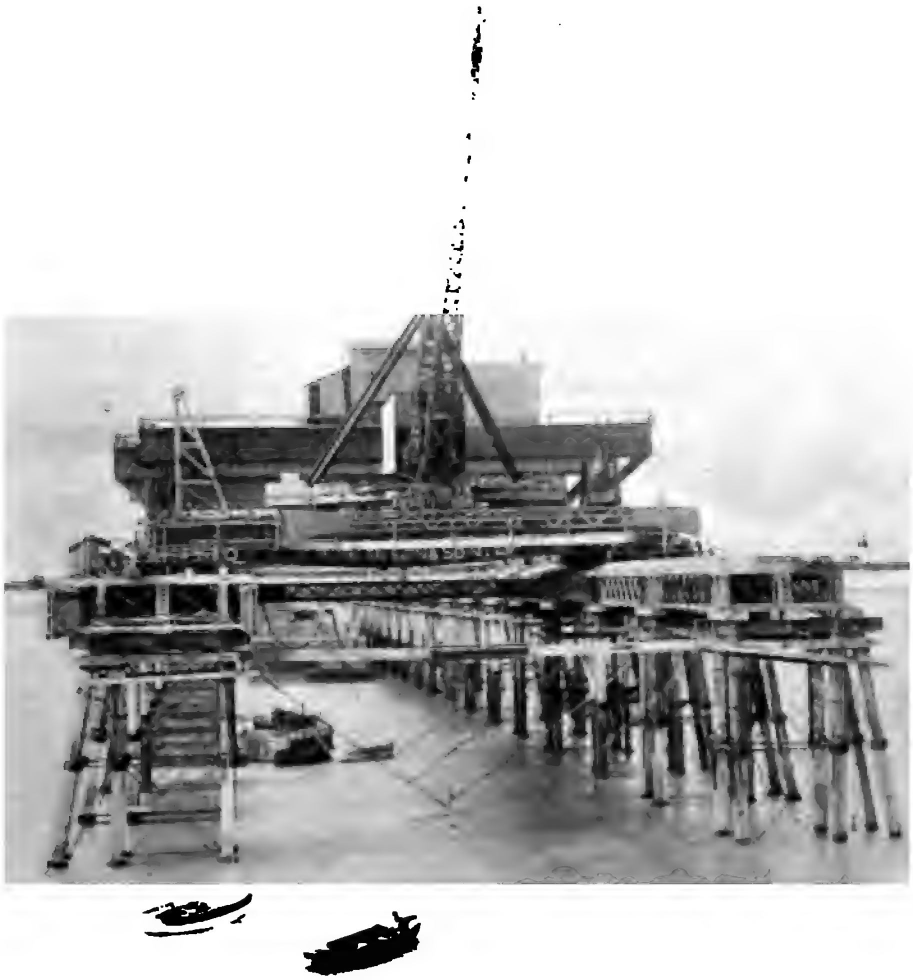


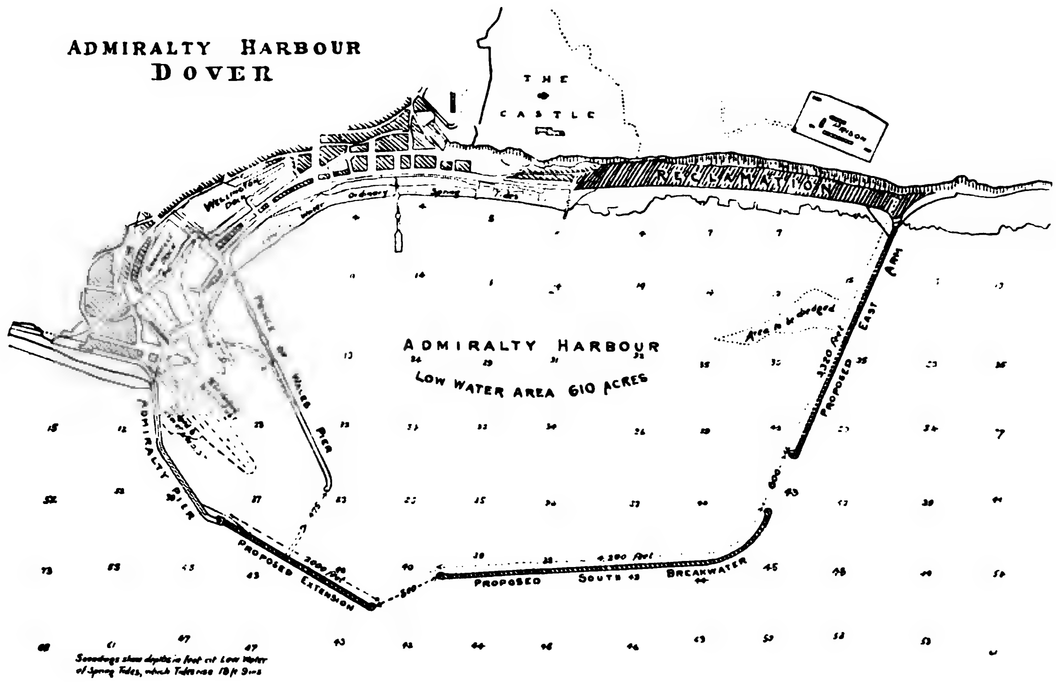
A VIEW OF THE TEMPORARY STAGING OF THE EAST ARM, TAKEN FROM THE SEA.

The general view of the extension, shown in the frontispiece, includes also the Prince of Wales Pier. Between these is the commercial harbour, in which the Dover Harbour Board intend to shortly commence further works for the accommodation of passengers embarking on or landing from large Atlantic liners.

It will be seen that entrances of 600 ft. and 800 ft. are provided at the extremities of the south breakwater, the Admiralty Pier extension being formed considerably south of the western end of the detached breakwater, in order to protect vessels which are entering the harbour when the tide is running with a strong current eastward.

The concrete blocks employed on the works range from 10 to 40 tons in weight. They were at first manufactured at Sandwich, but on the completion of the reclamation wall under the cliffs, part of the enclosed area having been filled in with chalk, scarped from the cliffs, was appropriated for concrete manufacture. A view of this workyard is shown herewith.

Powerful Goliath cranes are employed to work the grabs, which remove all loose material



overlying the chalk, and also for handling the large diving bell employed in the excavations, and for setting the blocks. The accompanying views of the east arm and temporary stagings will sufficiently indicate the nature of the appliances used and also the relative size of the blocks.

The latter are carefully bonded and are keyed together by joggles both above and below water, while from the low-water mark upward they are also set in Portland cement.

Under favourable conditions it is anticipated that the work will be finished in 1908. The estimated cost is about £3,500,000.

FRONT VIEW OF THE NEW BUILDINGS.

FAMOUS TECHNICAL INSTITUTIONS.

The second of a series of illustrated articles, giving brief descriptions of the most important technical institutions at home and abroad. The first of these described the Massachusetts Institute of Technology, and appeared in the January issue of PAGE'S MAGAZINE. In the present article Mr. Smith describes the power station of the university. A subsequent article will deal with the foundry and forge, the huge laboratories and workshops which will form what are called the main buildings, and the detail equipment of the mining and metallurgical sections.—ED.

II.—THE BIRMINGHAM UNIVERSITY.

BY

C. ALFRED SMITH, B.Sc., A.I.E.E.

PART I.

BETWEEN five and six years ago the public in the Midlands had placed before them the idea of a local university, with its headquarters at Birmingham. The prime mover in the scheme was the man to whom Birmingham owes so many great improvements, and who, during his three years of mayoralty, won for it the proud title, "the best governed city in the world," viz., the late Colonial Secretary and the first Chancellor of the University of Birmingham, the Right Hon. Joseph Chamberlain, M.P.

DEGREE DAY
The Chancellor leaves the University.

At that time probably not even the Chancellor himself foresaw the wonderful development which has grown from the original idea. With the remarkable perception of the events of the day which have made him so famous, however, he immediately grasped the fact that if this new university was to be famous, it must supply a demand and fill a gap in some branch of our higher education. It would have to be a useful education, one such as had not up to then been obtainable at the older seats of learning at Oxford and Cambridge, and it would have to be one which would have a distinct influence on local industries. In a word, it was to be technical education in which this university had to specialise to become of real service, both locally and nationally. The spirit of this early idea has been carried out to the letter and while the primary object of a university—that it is to be a seat of all learning and an establishment for the promotion of original research—has been always kept in view, yet the intention with which the promoters started has been ever present in their minds. This university of the Midlands was always meant to be developed in accordance with modern conditions and the needs of the great district for whose benefit it was founded.

At the outset the promoters were more

modest than they are at present. They only asked, then, for a quarter of a million of money, but they were soon convinced that at least £1,000,000 was wanted. To complete the scheme now in hand will require, it is thought, some £3,000,000. An early donor was Mr. Andrew Carnegie, who gave £50,000 and the useful advice that the Birmingham authorities should see what the United States and Canada were doing. Accordingly, a committee was appointed, consisting of Mr. George Kenrick, at that time Chairman of the Birmingham School Board, and now Chairman of the Education Committee and a member of the University Council, and Professors T. H. Poynting, F.R.S., Dean of the Faculty of Science, and F. W. Burstall, M.Inst.C.E., Professor of Civil, Mechanical, and Electrical Engineering. These gentlemen visited the States and Canada four years before the Mosely Educational Commission was thought of, and made a special study of the facilities offered there for technical education. The report which they presented on their return to the Council and Senate of the University, convinced these bodies that the state of higher technical education in this country was at that time not to be compared with that of the great nation across the Atlantic; also that it was urgent to build for the future. Owing to the generosity of a local landed proprietor, Lord Calthorpe, a site of thirty acres of land was then placed at the disposal of the University authorities. The position was not ideal, for the new site was two miles from the centre of the city, but there was a good train and tram service. And it was, of course, impossible to think of such a large tract of ground in the centre of the city. "Accordingly," said the Chancellor, recently, "we laid our plans for the great buildings which will be, we hope, a glory to the city and a worthy home for its University."

Yours faithfully
Oliver Lodge

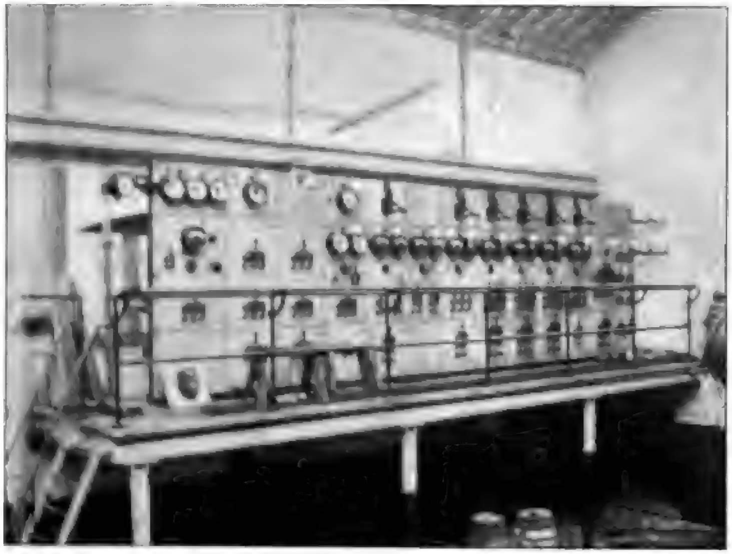
THE POWER STATION.

At the present moment there is erected at the new site at Bournbrook, a power-house for supplying electricity for light and power, and experimental purposes, and steam and gas for heating and cooking purposes, for use of the main buildings. This power-house consists of a boiler room 40 ft. by 60 ft., an engine room adjoining it 50 ft. by 100 ft. and a small drawing office and laboratory. The equipment of this place is unique, and has been entirely

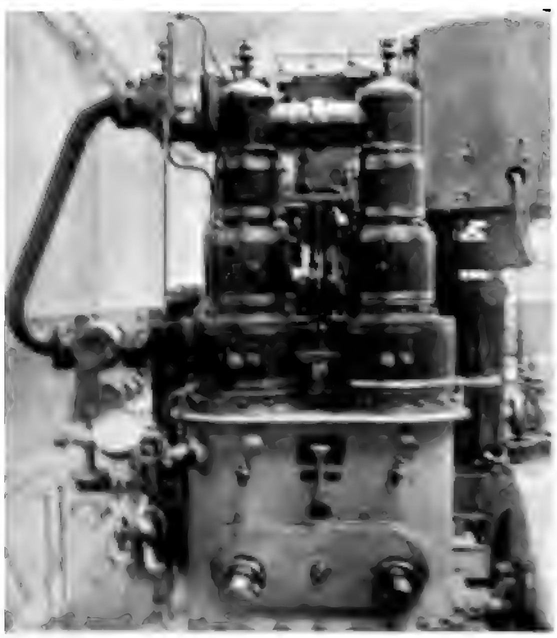
PROF. POYNTING, F.R.S.,
Dean of Faculty of Science.

carried out, by the engineering staff of the university, according to the ideas of Professor Burstall. In the engine room are two quick revolution engines, each of 100 b.h.p., both being munificent gifts of two well-known Midland firms, Messrs. Willans and Robinson, and Messrs. Belliss and Morcom, Ltd. To the Willans set, is coupled a Siemens compound wound direct-current dynamo which generates 540 ampères at 110 volts. The Belliss' set drives a direct-current Bruce Peebles dynamo, producing 70 kilowatts at 110 volts—117 volts complete. The largest steam engine was built by Messrs. McLaren, of Leeds, and is a triple-expansion marine type running at 120 revolutions per minute. The cylinders of the engine are 9⅛ in., 14¼ in., and 22½ in. diameter and the stroke is 2 ft. The air and circulating pumps are driven off the h.p. cross head, and the condensing plant is on the same bed plate with the engine. A Westinghouse three-phase alternator is direct coupled to the engine and gives 75 kilowatts at 220 volts, with a frequency of 30 cycles. A turbine supplied by Messrs. Greenwood and Batley, of the famous De Laval type, is situated between the Belliss and Willans sets, and the dynamo is driven by speed reduction gear of 10 to 1 at 2,000 revolutions. The output of this machine, which is direct-current, is 27 kilowatts at 110 volts. The remainder of the steam plant consists of a horizontal Ruston Proctor experimental engine, which drives, by means of a belt a direct-current generator of 15 kilowatts. The engine was originally used in the old heat laboratory at Edmund Street, and forms the only connecting link between the old order and the new. It is a compound engine, the h.p. cylinder being fitted with Corliss valves, while the l.p. works with an expansion valve gear. In addition to this list of steam engines, there are the gas engines, one by the Premier Gas Engine Company, of Sandiacre. The dimensions of this engine, which has been built to Professor Burstall's specifications, are of interest, for on it will be done the bulk of the experimental work for the gas engine research committee of the Institution of Mechanical Engineers. It is a single cylinder type, 24 in. diameter, driving a direct current Westinghouse generator, and 2½ ft. stroke, water jacketed and piston water jacket, positive scavenger type. There is also a three-cylinder vertical gas engine by the British Westinghouse Company. It drives, direct coupled, a direct-current generator by

BACK VIEW OF THE NEW BUILDINGS.



SWITCHBOARD AT THE POWER STATION.



[illegible] FROM MESSRS. W[illegible] AND [illegible]

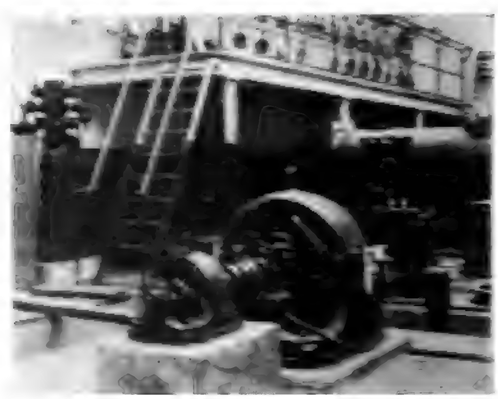
refrigerating machine by Haslams, of Derby. The condensing plants are by Messrs. Worthington and Weir, and are of the ordinary Marine pattern. The speciality of the Weir condenser is that two pumps are used—one for air at the top and the other for water below. The main switchboard consists of thirteen panels, of these four are A.C., seven D.C. and two artificial load made of vermont marble copper mounting. The cables throughout the station were supplied by Messrs. Glover, and are laid in cement troughs and covered with bitumen.

A rotary converter completes the machinery equipment of the power station. This is 37½ kilowatts capacity and will work in either direction having a separate exciter on the end of the shaft.

At one end of the station there is a bank of lamps which will be used as an artificial load. By a special arrangement on the switchboard, these lamps may be used for the direct-current load or the three-phase alternating-current load. The steam piping in the engine room is very elaborate in order to allow any engine to be using steam from any boiler. It is supplied by John Spencer, of Wednesbury, and has lap-welded piping and welded flanges.

The equipment of the boiler room when complete will consist of one Babcock and Wilcox boiler (and superheater), a locomotive, a Niclausse and two economic boilers. At present only the two first mentioned are in place, but the others are either on order or will shortly be ordered. A special feature of this boiler

the same company [illegible]



[illegible] ROTARY CONVERTER.

THE POWER STATION COOLING TOWER AND FOUNDRY.

laboratory it is probable that it will also be used for heating purposes. There is a cooling tower for the circulating water, supplied and erected by Worthingtons, but built by the Klein Engineering Company, of Liverpool, for cooling the circulating water for 1,200 lb. steam per hour. There is also a large cooling pond for this water.

The power station will be running in the new year, and already several of the senior students have been doing erecting and fitting work there.

THE FOUNDRY AND FORGE.

Adjacent to the power station are two buildings, similar in structure to it, but of somewhat smaller dimensions. One of these will be divided into two shops, the foundry and forge. The other is devoted to metallurgical work.

(To be continued.)

room is a gas-fired superheater—of Easton's type—and so arranged that the amount of superheat may be regulated by altering the quantity of gas supplied. Special arrangements have been made to read the superheat temperature on a dial with a pointer. The boiler room is designed for extensions, and is at present not so long as the engine room. Induced draught is obtained by a fan at the foot of a stack, the height of the latter being 100 ft. For supplying the gas for the gas engines and superheater there is a Mond gas plant capable of gasifying 5 tons of coal per twenty-four hours or producing over 29,000 cubic feet of gas per hour. This gas plant is situated just outside the power station, and since it is in close proximity to the metallurgical

THE POWER STATION ENGINE AND BOILER ROOMS.

NEW MACHINERY.

Spring-Testing Machines.

S[illegible] the [illegible] railways and [illegible] part of [illegible] show the [illegible] respe- [illegible] travelling at [illegible] is made [illegible] the [illegible] with [illegible] it is not [illegible] and conse- [illegible] and [illegible] to attain the [illegible]

[illegible] manufacturers [illegible] the selection of springs [illegible] springs [illegible] special [illegible]

ram, can be accurately measured by a steelyard and poise-weight, and the deflection noted. In some machines the only way to arrive at the deflection is to measure with an ordinary rule the height of the spring under each load and then deduct these heights separately from the original height of the spring. This is not a method to be recommended, as the necessary calculations may occasionally allow an error to creep in, and the same remarks apply to those machines in which no provision is made for mechanically deducting the weight of the spring and the holding appliances from the indicated load. A convenient and practical spring-testing machine should embrace the following features:— (1) The load must be capable of being read direct from the steelyard without having to subtract the tare-weight of spring and carriers from the gross load indicated by the steelyard. (2) The deflection of a spring under load should be read from the scale without respect to the original height of spring and without having to make any mental calculations. (3) [illegible] must be so arranged that springs can be tested under actual working conditions, [illegible] laminated springs with [illegible] horns and shackles, having [illegible] the same distance between scale [illegible] and with [illegible] shackle-plates at exactly the same angles as on the shackles on vehicle [illegible] inclination of shackle-plates having a somewhat marked effect on the deflection of spring-plates. Springs without [illegible] should have small [illegible] to carry the [illegible] the ends can rest on [illegible] the machine-table. Spiral and volute springs must be tested on a subsidiary table [illegible] a certain degree of [illegible] frictionless [illegible] rotation, otherwise the friction will cause the springs to appear stiffer than they really are. Spiral springs should be tested on a [illegible] mandrel to prevent [illegible] operator in the event of a spring breaking under test. (4) The weighing mechanism of the machine should be readily accessible, and at the same time [illegible] protected from dirt and grease. (5) The operator should [illegible] the whole of the indicating and controlling apparatus so arranged as to be at one side of the machine.

The [illegible] illustration shows one of the most

[illegible]

interesting products recently turned out by the West Hydraulic Engineering Company. It is completely equipped for testing laminated, volute, and helical springs. The machine was originally designed to meet a specification of the Madras Railway Company, whose consulting engineers, Messrs. Hawkshaw and Dobson, furnished several suggestions which assisted in the evolution of the machine in its present complete form. The machine, which is most conveniently worked from hydraulic pressure mains, but can also be actuated by power-driven or hand-pump, consists essentially of three distinct elements, viz., the loading, weighing, and indicating portions. The load is applied by a brass-lined hydraulic ram, working in a cylinder connected to the base by four steel columns, which also act as guides for the crosshead. Two gunmetal rams are employed to return the main ram.

The weighing apparatus consists of a heavy box section bed-plate and table, and the usual system of compound levers working on hard steel centres. The table is planed and provided with rails for the wheels of the small carriages seen in fig. 1. If, however, it is required to test spiral spring or volute springs, the same ball-bearing plate, seen on the floor at the left-hand corner of the engraving, is placed in position on the table, and the centre of this plate is recessed to take one end of a mandrel, which passes through the spring, and enters into the main ram, which is bored to receive it.

The indicating apparatus comprises the steelyard and deflection-scale. The former is of the double pattern, and the weight of spring and carriages can be balanced on the upper bar, and the load on spring read exactly on the lower. If preferred, however, the tare of spring, etc., can be counterbalanced by moving the special weight on a screwed extension of the bottom steelyard.

The deflection scale is of novel design. A square bar is fixed between an extension bracket on base and the entablature. On this bar slides a long, bronze fitting, carrying an engraved German silver rule. This rule can be raised or lowered on the bar, and locked by a small binding screw with milled head. On the same fitting is a pointer connected to a block sliding in a vee rod, with a friction spring. The working of this apparatus is as follows: the pointer block is raised until it is stopped by a tappet on the ram cross head, and the scale-bar is then adjusted until the pointer is on the zero line, and a turn of the milled screw locks the rule in its place. When the machine is started and the spring is depressed, the tappet on the crosshead moves the pointer, which gives a reading of exact deflection in either sixty-fourths of an inch, or in one-hundredths of the scale, which is marked in tenths, and the pointer is replaced by a Vernier. When the ram is raised, the pointer remains in the same position, so that there is no excuse for an incorrect reading. The weighing levers can be readily got at by screwing an eye-bolt into the table, and connecting same to crosshead, the power of the side rams being ample to raise the table. When in position the table protects the internal parts from dirt and scale.

The machine shown on the previous page was designed for springs up to 8 ft. long and 15-ton load, and the ram has a stroke of 20 in.

SPECIAL TYPE OF VERTICAL SINKING PUMP BY MESSRS. TANGYES, LTD.

A New Sinking Pump.

This "special" type of Vertical Sinking Pump is arranged so that it can be made to do its duty when suspended on chains in the pit shaft.

The bottom cover of the pump is hinged so that it may be swung back enabling the bucket to be taken out when required, without entirely removing the cover. The water end is fitted with a removable liner.

The pump illustrated has 21 in. steam cylinder, 10 in. pump, and 24 in. length of stroke. It is made strong enough for 400 ft. "head," and has a capacity of about 20,000 gallons per hour. It will be noticed that bolts have been used throughout wherever possible, in preference to studs, and the glands are fitted with T headed bolts.

One of these pumps, which are manufactured by Messrs. Tangyes, Ltd., was exhibited at the Colliery Exhibition.

The Guarding of Circular Saws.

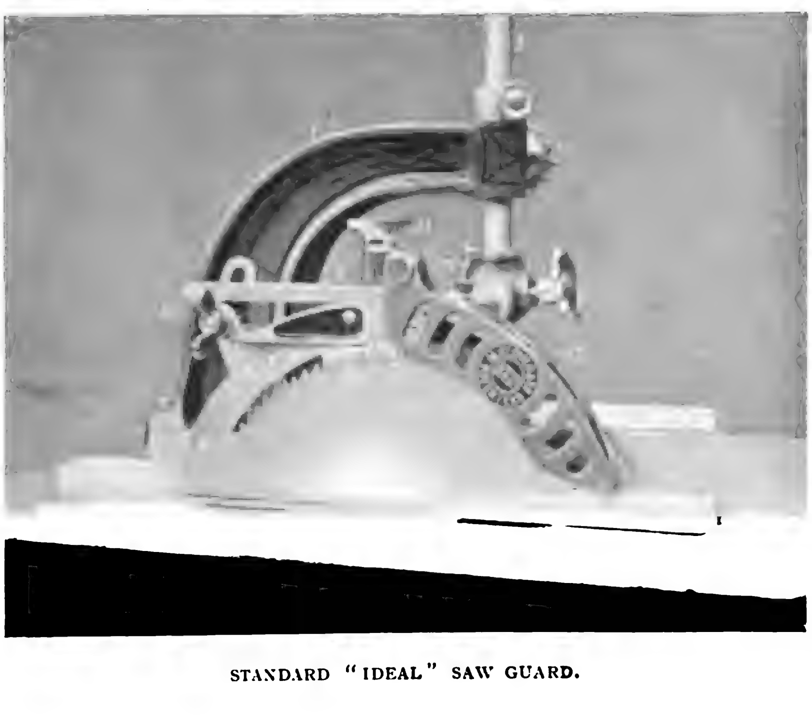
About four years ago a good many complaints were made in the press by practical people, who felt that some of the saw guards then available were positively obstructive and dangerous, while others failed to give adequate protection. The "Ideal" type of saw guard of Messrs. M. Glover and Co., saw mill engineers and patentees, of Leeds, which is here illustrated, has altered all that. Almost all discussion as to the alleged impracticability of saw guards may be said to have ceased, and what is more to the point, official statistics prove a great reduction in the number of accidents by circular saws.

These "guards" may now be seen in Government exhibition offices, museums, intelligence bureaux and institutions of various nations, to which they have by request been officially supplied as recognised standard inventions, and our illustration is from a photograph of one of these.

The guard is of brass and steel, neatly designed and finished. Its chief feature is its accurate adjustability, and as this, of course, is a most vital point in the construction of a saw guard, it may be useful to explain how the various adjustments are arrived at.

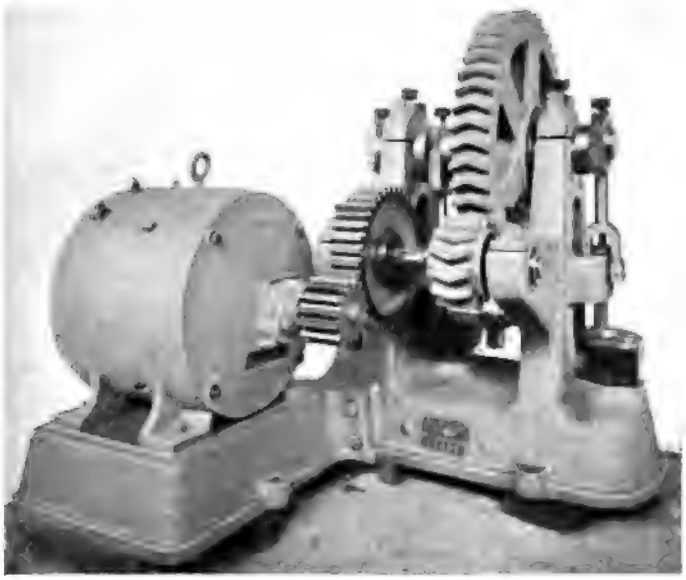
The illustration shows that a slightly *larger saw* than the one fixed may be used with the same guard by (1) raising the vertical shaft, 3, in the bracket which raises the whole guard; (2) by screwing down the milled screw, M, held by a lock nut on the top of the hood or front guard, which raises the front of the guard, thus assuming a larger circle; (3) by unscrewing the wing nut, W, and slightly raising the thin steel back blade with radial slot, 7, and (4) by pulling back the rack knife, 6, to admit of the larger diameter of saw, and which back knife is held firmly by a simple device underneath the table top.

In order to cause the "Ideal" guard to collapse circularly to fit smaller sizes of saws the reverse means are used, and all the adjustments can be almost instantaneously made. The vertical shaft, 3, is first lowered, carrying the guard down close to top of saw. The milled screw, M, is then unscrewed until the front hood, 12, falls on to the curved end of the tilting holder, 9. The tilting holder, 9, is next tilted up, thus raising the end, which is shown resting just above the "wing nut," and allowing the front hood, 12, to come lower or nearer to the centre of saw to suit the smaller saw desired, there being a simple "hinged bolt," 15, the round head of which just shows underneath the "tilting holder" almost vertically above the centre line of saw and this bolt fixes the "holder" in the required position. It is then necessary to unfasten the wing nut, W, and lower the "blade," 7, with "radial slot" to suit the saw, 7, after which the "back knife," 6, is moved closer to the smaller saw and fixed in position by a thumb screw under the table top. The bracket, 1, must be bolted to the table to allow of the shaft, 5, supporting the guard being fixed above and exactly central, and parallel with centre line of saw spindle, and the "back blades" or "knives" must be exactly in line with the saw. These are made of fine steel halved together at the joint to prevent obstruction.



STANDARD "IDEAL" SAW GUARD.

It will be readily seen that the "front hood," 12, bearing name can be at once lowered or raised, is held in position on the T slide on "tilting holder," 9, by means of the small hand wheel, 11, and bracket, while by a turn of the "wing nut," W, which is on a Theaded bolt, the "back blades" can be immediately disconnected from the brass portions of the guard, which can be swung round if desired for any particular purpose, and swung back again into exactly the same position by means of the safety collar on shaft, 3.



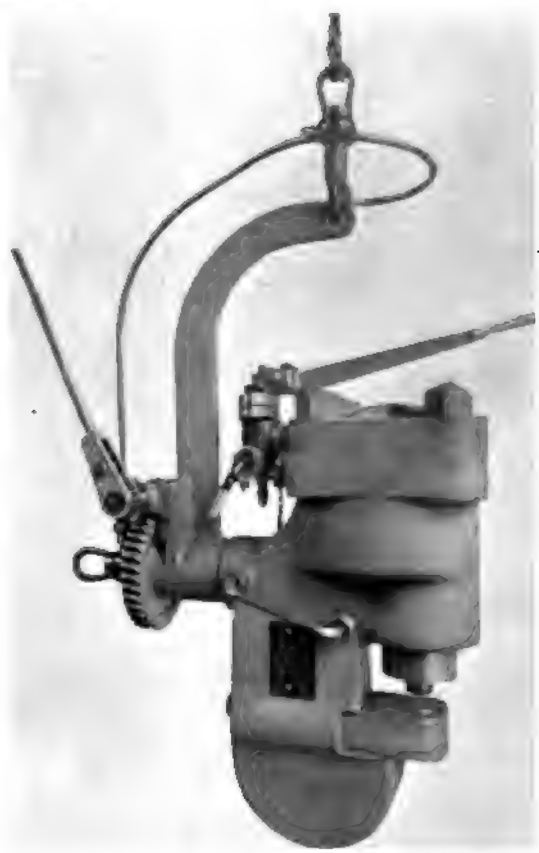
MOTOR-DRIVEN THREE-THROW PUMP. BY MESSRS. RICE AND CO., LTD., LEEDS.

Standard Motor-Driven Pumps.

We illustrate a standard type of motor-driven three-throw pump made by Messrs. Rice and Co., Ltd., Leeds. This pump is capable of delivering 300 gallons per hour at a pressure of 1,000 lb. per square inch, and the arrangement of three plungers gives an even delivery of water. The pump bodies and valves are of phosphor bronze, and are connected together to feed through one branch. The base of the pump standard forms the tank from which the pumps draw water. A cast-iron bedplate is bolted to the side as shown, and on this is carried the motor for driving. This motor is of the enclosed shunt wound slow speed type, and is capable of continuously developing 3½ b.h.p. at 220 volts and 500 revolutions per minute. On the end of the motor shaft is keyed a raw hide pinion, which gears into a machine cut spur wheel on the pump countershaft. The second motion is of the double helical type, and consists of a cast steel pinion on the countershaft, and a cast-iron wheel on the pump crankshaft. A starting switch is provided by means of which the pump can be automatically started and stopped from the hydraulic accumulator, or other machine to which it is desired to connect the pump. Special brushes are fitted to avoid any trouble through sparking, while every attention has been paid to the details of both pump and motor in order to ensure efficiency and reliability.

Boiler Riveting Machine.

With the introduction of boilers in which the end plate is flanged outwards for the flues, it has been found necessary to manufacture a special form of riveting machine for closing the rivets round the furnace mouth, and the illustration shows a type of machine for this special purpose which has been designed by Messrs. Rice and Co., Ltd., Leeds. The machine illustrated gives a pressure of 60 tons on the rivets, and is made very short over the cylinder so as to go into a flue of 2 ft. 3 in. diameter. The holder-up, which must be small enough to pass between the narrow place, where the two flues are close together, is a separate forging of high grade steel recessed into the steel body casting, and secured by a mild steel shank, which passes through the body, and is fastened by a nut on the back of the riveter. The holder-up is supported underneath by the frame casting as far as is possible to clear the flue flange when riveting. The whole machine can be easily adjusted round the complete circle by a mild steel worm and machine-cut worm wheel arranged on the hanger as shown.



BOILER RIVETING MACHINE. BY MESSRS. RICE AND CO., LTD, LEEDS.

THE SHIPBUILDING OF BELFAST.

LAST year Messrs. Harland and Wolff beat their own record—which is saying a good deal—reaching the enormous output of 110,463 tons, this being an increase of 30,966 tons on the record of the previous year, and 18,147 tons in excess of the total for 1901.

For the last three years the firm has sent out "the largest ship" for the time being, and it will therefore be surprising if the *Baltic* is allowed to retain this record permanently.

Of some thirty vessels of 12,000 tons and upwards built by British firms, Messrs. Harland and Wolff contributed twenty-four vessels of 351,422 gross tons, or an average of 14,643 tons each. The following is a list of vessels built by Messrs. Harland and Wolff of 12,000 tons and upwards :—

Name.	Gross Tonnage.	Name.	Gross Tonnage.
Pennsylvania ..	13,333	*Minnetonka* ..	13,398
Cymric	13,096	*Athenic*	12,234
Oceanic	17,274	*Walmer Castle* ..	12,546
Saxon	12,385	*Corinthic* ..	12,231
Minneapolis ..	13,401	*Ionic*	12,232
Minnehaha ..	13,403	*Cedric*	21,035
Commonwealth	12,097	*Arabic*	15,860
Runic	12,482	*Columbus* ..	15,500
Suevic	12,500	*Kenilworth Castle*	13,150
Celtic	20,904	*No.* 353	16,780
Ryndam ..	12,527	*No.* 354	16,780
Moordam ..	12,531	*Baltic*	23,763
		Total..	351,422

The following is a list of vessels of 12,000 tons and upwards built or building by all other builders, British or foreign :—

Name.	Gross Tonnage.	Builders.
Campania	12,950	Fairfield.
Lucania	12,952	"
Ivernia	14,058	C. S. Swan and Hunter
Carpathia .. .	13,555	"
Saxonia .. .	14,281	J. Brown and Co.
Pretoria . ..	13,234	Blohm and Voss.
Potsdam	12,522	"
Blucher	12,334	"
Graf Waldersee ..	13,193	"
Moltke	13,335	"
Deutschland	16,502	Vulcan Company.
Patricia	13,424	"
Kaiser Wilhelm der Grosse	14,349	"
Kaiser Wilhelm II. ..	19,360	"
Kronprinz Wilhelm ..	14,908	"
Grosser Kurfurst ..	13,182	F. Schichau.
Kaiser Friedrich ..	12,480	"
Kroonland	12,760	W. Cramp and Sons.
Finland	12,760	"
Mayflower	13,507	Hawthorn Leslie.
Manchuria ..approx.	13,300	New York Shipbuilding Company.
Mongolia	13,300	"
Minnesota ..approx.	21,000	Eastern Shipbuilding Company, New London.
	322,246	

Twenty-three vessels ; average, 14,010 tons.

MESSRS. HARLAND AND WOLFF'S LATEST LEVIATHAN—THE "BALTIC."

A VIEW OF THE YARROW CONVALESCENT HOME.

The Yarrow Home for Convalescent Children at Broadstairs.

THE Yarrow Home for Convalescent Children of the Better Class at Broadstairs has lately, by the desire of its founder, Mr. A. F. Yarrow, M.Inst.C.E., come under the control of the Institution of Civil Engineers in the following manner: The Home and its endowment fund have been vested in trustees appointed by the Council, the first trustees being Sir William White, K.C.B., President Inst.C.E.; Sir John Wolfe Barry, K.C.B., Past-President Inst.C.E.; and Sir Alexander Binnie, Vice-President Inst.C.E.; with Mr. A. F. Yarrow. The Council have also undertaken to appoint, from time to time, as may be required, the members of the Managing Committee of the Home, it being a condition that the committee shall in future be composed wholly of members of the Institution of Civil Engineers, and, in respect of two-thirds of them, of past or present members of the Council of the Institution, or of the Committee of Management of the Benevolent Fund of the Institution.

It is anticipated that, incidentally, the children of engineers and members of their staffs, who are not in affluent circumstances, should be very greatly benefited by the changed conditions under which the Home will be conducted in the future.

The Home is a model of orderliness and comfort, and since its inauguration has been of incalculable value in ameliorating the lot of juvenile sufferers. The seventh annual report which is before us shows that during the year ended December 31st, 1902, the total number of children admitted was 942, of whom 451 were boys and 491 girls; among these being 145 children who had lost either one or both their parents. Since its opening in August, 1895, something like 7,000 children have passed through the home as follows:—

	Number admitted.	Average number.	Average length of stay.	Number of "child-days."
For the year 1896 ...	553	46	31 days	17,082
„ „ 1897 ...	601	52	31 „	18,569
„ „ 1898 ...	947	70	27 „	25,409
„ „ 1899 ...	938	72	28 „	26,433
„ „ 1900 ...	939	73	29 „	27,427
„ „ 1901 ...	1,040	80	28 „	29 023
„ „ 1902 ...	942	80	31 „	29,239

The following table is an abridged statement of income and expenditure during the six years, 1897-1902:—

	Income. £ s. d.	Expenditure. £ s. d.
1897 ...	3,699 10 0	... 2,728 19 6
1898 ...	3,898 11 5	... 3,821 17 10
1899 ..	3,997 1 1	... 3,928 5 6
1900 ...	4,088 16 7	.. 3,963 0 1
1901	4,276 15 2	.. 4,569 15 8
1902 ..	4,421 17 5	... 4,461 4 4

The Yarrow Home is likely to be of incalculable value to the profession, and will also serve as a standing record of the keen interest taken by Mr. Yarrow in the interests of the profession.

The above information and illustration of the home we owe to the courtesy of Dr. J. H. T. Tudsbery, Secretary of the Institution of Civil Engineers.

OUR MONTHLY BIOGRAPHY.

SIR JOHN WOLFE BARRY, K.C.B., F.R.S, LL.D.

THE youngest son of the late Sir Charles Barry, R.A., architect of the Houses of Parliament, Sir John Wolfe Barry was born in London in 1836. He was educated at Trinity College, Glenalmond, and King's College, London.

His professional career was commenced by a pupilage under Mr. (afterwards Sir John) Hawkshaw, to whom he subsequently became assistant, and, on the completion of the Charing Cross and Cannon-street Railway Bridges and Stations, in connection with which he had been resident engineer, he commenced practice independently as a civil engineer.

Many of our most important public works bear the stamp of the genius of Sir John Wolfe Barry, notably The Tower Bridge, on the successful completion of which he was made a C.B., while in the Diamond Jubilee year he was promoted to K.C.B., and received the honour of knighthood.

Among other important works carried out by Sir John Wolfe Barry may be mentioned the completion of the Inner Circle Railway through the City of London from the Mansion House to Aldgate, and the extension to Whitechapel, the building of St. Paul's Station and Railway Bridge at Blackfriars for the London Chatham and Dover Railway Company; the immense Barry Docks and large system of railways in connection therewith; the King Edward VII. Bridge at Kew; and extensive dock extension works at Grangemouth, Tyne Dock, Middlesbrough, Bristol, and Surrey Commercial Docks.

Photo by Alfred Ellis and Walery.]

SIR JOHN WOLFE BARRY, K.C.B., F.R.S., LL.D.

He acts as consulting engineer to the Caledonian, London Chatham and Dover, Metropolitan, Metropolitan District, and Barry Railway Companies; also to the Bridge House Estates Committee of the Corporation of London, the Commissioners of the River Tyne, the Surrey Commercial Docks, the Regent's Canal and Dock Company, the Bengal Nagpur Railway, and the Bombay Port Trust.

In the course of an exceptionally active career, Sir John Wolfe Barry has given his time unstintedly to the public service in various directions. He served on the Royal Commission on Irish Public Works, and on the Commission on the Western Highlands and Islands of Scotland; also on two Commissions which were appointed by the Board of Trade to deal respectively with the estuaries of the Ribble and of the Thames. He, with Sir Charles Hartley, K.C.M.G., represents Great Britain on the Suez Canal International Commission for Works. He was a member of the Royal Commission on Accidents to Railway Servants, and on the Board of Trade Committee on the Vibration of Tube Railways. He is a member of the Royal Commission on London Traffic, and of the Court of Arbitration appointed under the Metropolis Water Act, 1902, for the purchase of the London Water Companies.

Sir John has for some years shown an active sympathy with the Volunteer movement. He is a Lieut.-Colonel in the Engineer and Railway Volunteer Staff Corps, and a member of the Army Railway Council.

For two successive years (1897-98) he was President of the Institution of Civil Engineers, and in 1898 and 1899 filled the Chair of the Society of Arts.

He has taken a great interest in Technical Education and is a member of the Senate of the University of London, Chairman of the Executive Committee of the City and Guilds of London Technical Institution, and a member of the Council of King's College.

He was mainly instrumental as President of the Institution of Civil Engineers in 1897-8, in securing the adoption by the Council of the system of examinations for admission to the Institution, and also in the inauguration and development by means of a representative committee of a system of Standardisation for the Engineering Trades of Great Britain.

His contributions to the technical press include "Railway Appliances," 1874-92; "Lectures on Railways and Locomotives," 1882; "The Tower Bridge," 1894.

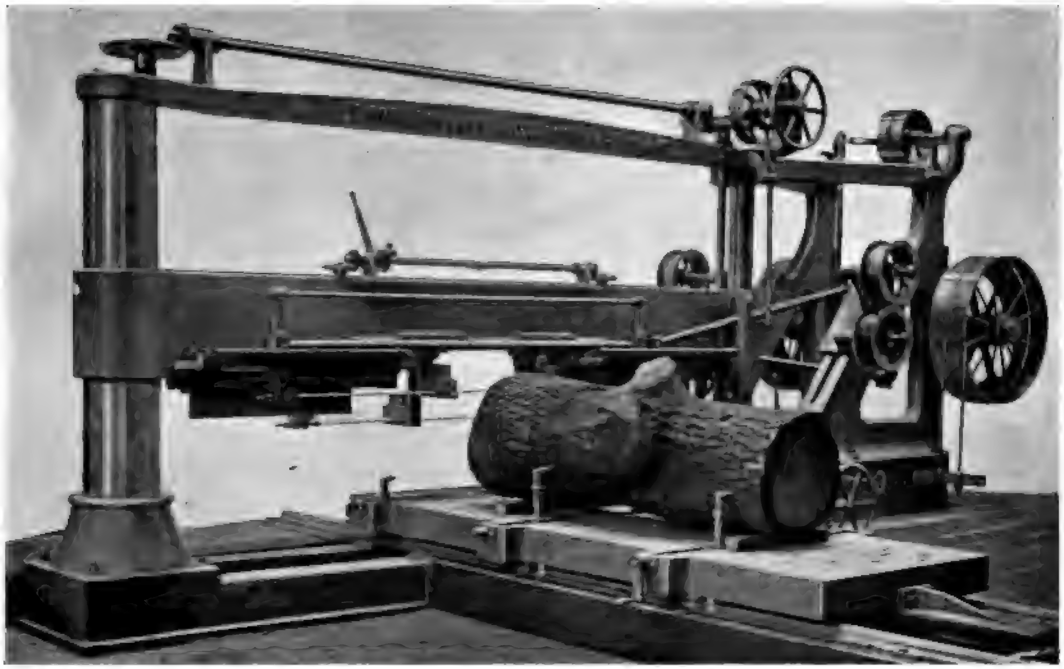


FIG. I. DOUBLE HORIZONTAL SAW FRAME.

A TYPICAL INDIAN SAW MILL PLANT.

BY

HORACE A. GASS (*Indian Forest Service*).

The saw mill here described is an interesting example of the use of water power in India, and illustrates the great advantages possessed by the Pelton wheel, where a reasonable fall and a sufficient supply of water can be obtained.—ED.

THE Anaimalais, or Elephant Hills, of Southern India, are in parts covered with extensive deciduous forests, containing large supplies of valuable timber trees. Fires in past years have caused such injury to the standing stock that the quality of the timber is very inferior, and the logs are now almost without exception unsound, with heartshakes, decay, twists, knots and cracks. This affected the selling price so much, that it was decided to abandon log sales, and to establish a plant for working up the timber in the forest, so that only sound wood in saleable sizes might be sent to the markets.

A small river flows through these forests, falling in one part over a ledge of rock 86·75 ft. high from crest to foot, and creating, what is locally known as, the Tunakadavu waterfall.

Above this fall, the catchment area of the river is about four square miles. The average rainfall is between 50 and 60 in. during the S.W. and N.E. monsoons, scattered over the months, June to January. From the end of January till the middle of June the rainfall is almost nil; the river dries up, the whole forest becomes unhealthy, and work is suspended.

The scheme was to construct a dam above the fall and lead the water through a channel to a point above the river as far as necessary below the waterfall, to secure a fall of not less than 100 ft., and to establish a saw mill by the side of the river, and work it by water power with a Pelton wheel.

THE DAM.

The dam is of masonry, built upon, and into, the rock. It is nearly 80 ft. long, 8 ft. high, 4·5 ft. thick at the base, and 2·75 at the top, and is provided with masonry wing walls backed by earthen banks, raised 4·5 ft. above the dam level, and above any probable flood. A pool is formed about 700 ft. long, of an

FIG. 2. EXTERIOR OF THE MOUNT STUART SAW MILL.

average width of about 40 ft., and a depth of 5 ft., giving a supply of about 140,000 cubic feet of water. During rainy weather the inflow exceeds the quantity consumed in the mill, and the water flows steadily over the dam. After a prolonged period of fine weather, the water decreases a foot during a day's work, but the pool fills up again during the night.

THE SLUICE AND CHANNEL.

The water runs through a tunnel in the left hand wing wall, the entrance to which is provided with an iron shutter, raised by a screw.

The dug channel is 2,385 ft. long, of an average width at bottom of about $2\frac{1}{2}$ ft., with sloping sides. In a few places, where excavation was found to be impracticable, and where ravines had to be crossed, masonry walls have been built. The channel follows the contour of the ridge, and has a fall of $1\frac{1}{2}$ in. per 100 ft., giving a velocity of about 100 ft. a minute. The water runs about 12 in. deep, and the volume is from 250 to 300 cubic feet a minute. The channel is provided at its lower end with a second sluice-gate, which can be closed when the water supply is short, to back the water up in the channel, when the mill is not working. The water passes over a wooden flume into a cistern which contains the pipe head, and is provided with an opening at the back to carry off the surplus water into the overflow channel.

THE PIPE-LINE.

The vertical fall of the main pipe-line is 125·64 ft. and its length 250 ft. The pipes are riveted steel, tested to a pressure of 100 lb., with socket and spigot joints, and coated with a bituminous composition, which increases their durability. The bell-mouthed pipe-head is 16 in. in diameter, that of the upper half of the pipe-line is 12 in., and of the lower 10 in. The pipes are laid along the surface of the ground and covered with earth. At every 50 ft. they are securely anchored.

An air-pipe is tatached just below the bell mouth, and to prevent small stones and *débris* from entering the pipes the cistern and pipe-head are each protected with two layers of wire netting of fine mesh.

THE SAW MILL AND MACHINES.

Fig. 2 shows the exterior of the saw mill, which is 90 ft. by 45 ft., roofed with corrugated iron, supported on masonry walls and pillars, and open nearly all round. It contains the following machines: The Pelton wheel, which is described below; a double horizontal saw frame; a 24 in. pendulum or swing cross-cut saw; a saw sharpener for frame and circular saws; a circular saw with wooden frame and travelling carriage, and 48 in. saws; a circular saw bench for saws up to 24 in.;

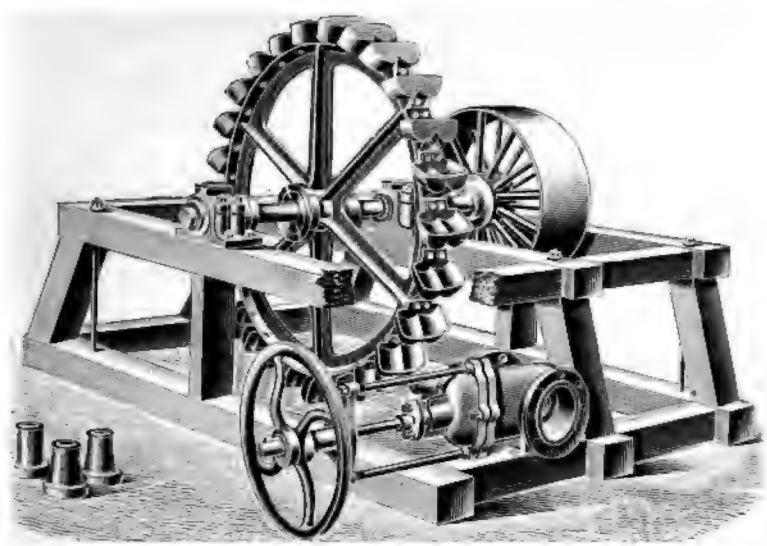


FIG. 3. PELTON WHEEL WITH PLAIN SLUICE VALVE.

a double acting horizontal pump; a 2-ton crane; an overhead 1-ton travelling block for raising logs.

With the above combination of machines, logs of 24 ft. length and 30 in. face can be worked into scantlings of any size.

The horizontal saw (fig. 1), is used for the conversion of rough logs into boards and planks up to 7 in. thickness. The logs are firmly fixed to a cast-iron carriage, which travels automatically at slow speed. The machine works with two saws at once, mounted on separate frames driven from a two-throw crank, having opposite centres. The motion of one saw thus balances the other in equilibrium, and allows of a high speed with little vibration and wear and tear. The hardest woods are cut easily, leaving a surface as even almost as if it had been planed. This machine requires little power, less than 10 b.h.p., and can be worked with ease and rapid change of cut.

Fig. 5 illustrates the swing cross-cut saw, which calls for no explanation.

The saw sharpener is shown in fig. 6, which explains itself. The sharpening is done by means of emery wheels, with excellent results. These three machines are by T. Robinson and Sons, of Rochdale.

THE PELTON WHEEL.

Fig. 3 shows a Pelton wheel. This is a development of the old Hurdy-gurdy wheel, with flat wooden floats, which was common in America and some European countries years ago.

The name is derived from that of an American, who, some twenty years ago, devised a bucket with a backward curve and central division or splitter, which, entering the sphere of the jet, causes the water to divide and flow round the curve of the bucket, and to leave it in an opposite direction to that of rotation, having given up all its force in propelling the wheel.

The buckets are placed at equal distances round the wheel, with the sides at an angle of 75°, which enables the water to escape in a thin stream without striking the following bucket. Different forms of bucket have been tried at different times, in order to overcome the objection to the bucket, when entering the range of the water-jet, momentarily deflecting the stream, but the plain bucket shown in the figure has proved to be the best shape, always provided that its front is placed at an angle, and does not come down flat upon the water. The circumferential velocity of the wheel is about half the theoretical velocity of the jet due to the head, the actual velocity being about 85 to 90 per cent. of this in a smooth jet, which gives the best results. The theoretical velocity is $482\sqrt{\text{head}}$ in feet per minute.

Pelton wheels are adapted to falls from 50 ft. upwards; they can be used for lower falls, but become large, and are less efficient, and more costly, than turbines would be. For high falls no better machines exist, and they can be used with enormously high ones. For example, a 24 in. wheel is in use on the London pumping mains, which, with a jet of only 3-16th diameter, works under a pressure of 900 lb. to the square inch, equivalent to a head of 2,100 ft. Pelton wheels are not affected by the quality of the water working them, and there is no immediate contact with the working parts, as in a turbine. They are

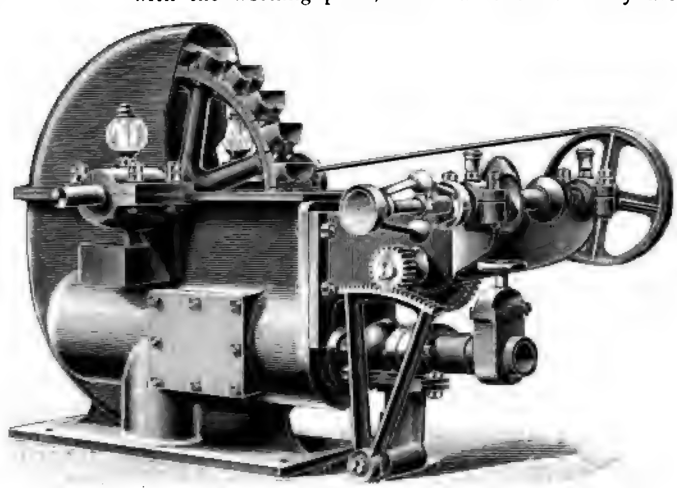


FIG. 4. PELTON WHEEL IN IRON CASING, FITTED WITH GOVERNOR.

FIG. 5. SWING CROSSCUT SAW.

extremely durable and are especially adapted to localities where repairs in complicated machinery are difficult and costly to effect. For even if the buckets, the only vulnerable parts of the machine, get broken or worn out through the action of sand in the water, they can easily be renewed. These considerations led to the selection of the Pelton wheel as the most suitable motor for working the Mount Stuart Saw Mill.

[illegible] wheel [illegible] the mill [illegible] Waverley [illegible] working [illegible] pairs [illegible]

The wheel is mounted on a strong teak-wood frame, made locally.

After leaving the wheel the water falls into a trough, and flows through a built channel, under the floor of the mill. Very little water is carried round the wheel by the centrifugal force, and to prevent splashing the sides of the frame are closed in, and a semi-circular wooden cover is fitted over the wheel, which can be lifted off when necessary.

The nozzle is 2[illegible] in. diameter, and is capable of passing about 200 cubic feet of water per minute, under a head of 125·64 ft., giving out about 30 b.h.p. The shaft is fitted with a 3[illegible] in. driving pulley making about 225 revolutions. The nozzle piece is screwed on to a strong casting, bolted firmly to the wheel frame, so as to resist the reaction of the water issuing from the nozzle with a velocity of about 4,500 ft. a minute. The water can be entirely cut off by a plain sluice valve, fitted to the main pipe, close to the wheel similar in construction to that shown in the illustration. This is closed when work stops, and the hand wheel is chained up, as a precautionary measure. The nozzle is fitted with a rod, passing through its centre, with a spear-head shaped end, which can be withdrawn from, or screwed forward into, the cavity, as more or less power is required.

Fig. 3 does not illustrate this method of meeting variation of load which was designed by Messrs. Carrick and Ritchie. It is the best possible device, as, while the effective area of, and the quantity of water flowing through, the nozzle are reduced, the pressure remains the same. It is to be preferred to that of increasing the power by means of two or more nozzles, which can be raised to play upon different buckets, or deflected to allow the water to run waste, or that of varying it, by means of nozzles of different sizes, which have to be attached, as required, or that of decreasing it by throttling the water by a valve, and thus reducing the pressure. The area of the nozzle is sufficient to pass the maximum quantity of water given above, but it is found in practice that this quantity is never required. The flow can be regulated instantly to meet the demand by turning the hand wheel attached to the rod, and while the Pelton is always working under a full head great economy of water is effected.

It might be presumed that in screwing the displacer back against the pressure, much effort would be required, but this is by no means the case, and the power can be easily and rapidly increased. With a full head the pressure is 54¼ lb. to the square inch. A pressure gauge is attached to the pipe, and is a necessity. A relief gauge is also in use, and a valve for regulating the supply of water to the pump tank.

THE STAFF AND LABOUR SUPPLY.

The carriage of such heavy and unwieldy loads into the heart of the forest was beset with difficulties which would have been largely increased without the tramway line running from the head of the Ghaut Road and the trained elephants. The services of expert fitters in such a locality were also of course hard to get.

The staff now consists of a supervisor and four fitters, two of whom are Malabar natives. A number of coolies have also to be employed daily in shifting logs and sawn timber, and doing jobs connected with the working of the machines and sluices. These men, who belong to a local aboriginal tribe, display considerable intelligence and aptitude, and there has never been an accident in the mill.

OUTPUT OF THE MILL.

About five or six logs, or 250 to 300 cubic feet could be passed daily through the horizontal, but, allowing for loss of time in conversion into sizes on other machines, the actual output does not exceed 100 to 150 cubic feet a day, or about 20,000 to 25,000 cubic feet for the season. There is, of course, a loss of about 30 per cent. of unsaleable wastage, but the selling price per cubic foot of the sawn wood brought to market is more than double that of timber in log.

THE WATER SUPPLY.

The hill occupied by the staff, known as Mount Stuart, to commemorate the visit of a former Governor of Madras, is 450 ft. above the saw mill site. The water requirements of the camp are met by a small double acting horizontal pump, made by Messrs. Hayward, Tyler and Co., of Luton, which delivers the water, drawn direct from the Pelton pipe-line, through a $1\frac{1}{2}$ in. rising main into a large tank at the top of the hill, at the rate of one hundred gallons per hour.

PRECAUTIONS AGAINST INJURY.

The fears that were entertained of injury to the main sluice and wing walls, the channel and even to the mill at night by wild elephants, have proved to be groundless, and the stockade that was constructed round the mill has been removed. The risk of injury to the mill site from floods, which was once very threatening, has since been met by cutting away the bank opposite to the mill considerably, and widening and straightening the waterway.

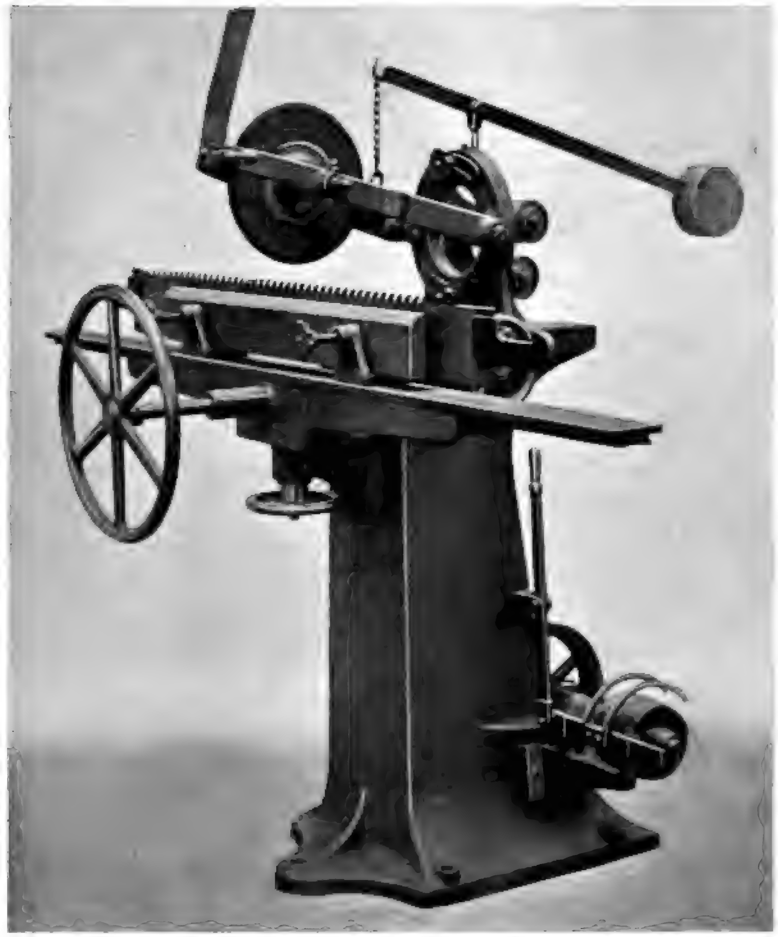


FIG. 6. SAW SHARPENER.

Pelton wheels can be obtained self-contained in an iron casing in a specially portable form, and fitted with a governor to regulate the speed, as shown in fig. 4. They can be adapted to working the heaviest machinery and the lightest loads, such as driving ventilating fans, punkahs, and even dentists' drills, and could be usefully employed in many private houses, where a suitable fall of water is available, for such domestic purposes as working an ice-machine, pumping water, and electric lighting.

NOTES ON THE WESTPHALIAN COAL FIELD.

BY

DAVID A. LOUIS, F.I.C., M.I.M.E., M.A.I.M.E., F.C.S.

In the previous articles, the author dealt with the various methods of working the coal and the systems of transport and winding employed.—Ed.

III.

WATER.

THE field is a very wet one, and 678 gallons of water, or over 3 tons, have to be raised to every ton of coal. The wettest mines are Gneisenau, Courl, and Erin, with a yield of 3,521, 2,432, and 2,421 gallons per minute, respectively. Dams are largely used in the district, and since the introduction of underground pumps, sumps are made of sufficient capacity to hold 24 to 48 hours' drainage; they are placed only from 9¾ ft. to 16¼ ft. below the lowest level, so as to avoid too great a lift for the pumps. In fact, if by chance the force pumps are fixed at a higher level, auxiliary pumps are employed to lift water from the sump to the higher level. In 1900 there were 51 geared single-acting pumps, 49 direct single-acting pumps, and 40 Woolf pumping engines, all on the surface. The largest Woolf engines had cylinders with 70⅕ in. and 94⅖ in. diameter, and 110-in. and 177-in. stroke.

The Gneisenau hydraulic pump is already well known. Underground pumps have only been slowly adopted owing to the fear of their being drowned; to the objection of taking steam underground, and to the loss of steam pressure by condensation; but these prejudices have been overcome, and the use of underground pumps is becoming quite general. Horizontal fly-wheel engines, with plungers connected directly to the piston-rods, are the particular fancy of Westphalia. There were scarcely any geared pumps underground, but all varieties of the favourite type were in use at the time of the writer's visit.

The engines were single, twin-compound, tandem-compound, and twin-tandem compound, all provided with condensers. The pumps were single-acting, double-acting and differential. A fine and remarkable specimen of the twin-tandem compound condensing engine built by Haniel and Lueg, of Düsseldorf, is located 1,640 ft. underground in Gneisenau Colliery. It has triple expansions in four cylinders, and is employed for the drainage of that mine and its neighbours, Courl and Scharnhorst. The lifting capacity is 5,580 gallons per minute, representing about 2,800 h.p. in water lifted, or 3,400 to 3,500 i.h.p. The chief dimensions of this engine are: high-pressure cylinder, 37⅖ in. diameter; intermediate cylinder, 49 in.; the two low-pressure cylinders each 65 in.; the pump plunger, 11⅕ in.; stroke, 66 9/10 in. A remarkable feature of this engine is its extraordinary length, the distance from the barring engine at the edge of the fly-wheel end to the centre of the suction pipes in the shaft is about 110 ft. the greatest width, however, is about 25 ft. This peculiar arrangement had to be adopted to suit the breadth of an engine room restricted to 26¼ ft. Each pair of cylinders is arranged symmetrically and coupled at right angles to the fly-wheel, which is 21 ft. 8 in. in diameter, and has a tooth rim and a small barring engine for starting. Each side has a double-acting forcing set formed of two single-acting plunger pumps placed back to back, coupled by outside rods and a box condenser and air pump all in one line, the air pumps doing duty as suction lifts in the shaft. The length of the line of rod from the crosshead slipper at the fly-wheel end to the end of the air pump plunger is about 75 ft. All the cylinders and covers are jacketed, the steam admission valves are placed on the tops, and those for exhaust on one side of the cylinders. The high pressure admission valves are fitted with Wiegleb trip gear, and are under control of a governor allowing a variation of 30 to 35 per cent. in the number of revolutions while running. The normal working rate is 60 revolutions, and the piston speed then is 670 ft. per minute. The other admission valves and the exhaust valves are worked by eccentrics from a shaft running parallel to the centre line of the cylinders, receiving motion from the fly-wheel shaft by screw and worm-wheel gearing. This remarkable engine, when working with a boiler pressure of 180 lb., and 165 lb. at the high-pressure admission valve, should consume 11·13 lb. of steam per horse-power in water lifted. It is illustrated in fig. 16. All the larger parts of this engine have been made in sections to enable them to pass down the shaft.

There were in use in 1900, 157 underground fly-wheel engines, 72 underground steam pumps without fly-wheel, and a good few hydraulic pumps utilising the pressure in rising mains. The Kaselowski system being particularly in vogue and doing good work; at König Ludwig mine, lifting 1,540 gallons from 1,722 ft.; at Graf Bismark, 440 gallons from 2,048 ft.; at Hansa, 550 gallons from 2,308 ft.; whilst at Rhein-Elbe No. III. there is a beautiful Kaselowski engine,

one of the many fine engine sin the magnificent engine house, raising 440 gallons from a depth of 2,543 ft., and does it with fascinating smoothness, whilst a similar one lifts 3,080 gallons from 1,300 ft. at Altendorf. There are other makers of useful hydraulic pumps. The Kaselowski installation at Rhein-Elbe III. may be selected to illustrate the character of such pumping plants in Westphalia. It was constructed by Maschinenbau A. G. vorm L. Schwarzkopff, Berlin, and its capacity is 70⅝ cubic feet of water per minute from a depth of 2,543 ft., with steam at 120 lb. admission pressure. The plant includes a horizontal twin-tandem engine without condenser, with cylinders 21⅝ in. and 33½ in. diameter by 39⅓-in. stroke, and with 120 lb. of steam, and 60 revolutions a minute, it gives 530 i.h.p. To this are directly connected two double-acting plunger force pumps, with plungers 2⅞ in. in diameter by 39⅓-in. stroke; these pumps force the water required to work the pumps into an air pressure accumulator under 250 atmospheres pressure. The accumulator is loaded by means of air compressed to 50 atmospheres by a vertical Kaselowski steam air compressing pump; there are two underground plants associated with this surface installation; one at 2,210-ft. level, to deal with the drainage of the new colliery Rhein-Elbe III., the other at the 1,510-ft. level, to deal with the drainage from the old collieries on the same concession. The former of these is a hydraulic-driven horizontal twin pump, with a working plunger 4¾ in. in diameter, and a 7-in. forcing plunger, with a common stroke of 23⅝ in., and can lift 70⅝ cubic feet a minute 2,543 ft. when making 30 strokes. The other pump is a vertical hydraulic twin pump, having working plunger 4¾ in., and forcing plunger 9¼ in. diameter, 19⅝ in. stroke, and when making 25 strokes a minute can lift 70⅝ cubic feet 1,510 ft. These pumps work alternately, so that the same rising main and pressure pipes serve for both. The advantages of hydraulic worked pumps are well appreciated in Westphalia.

Electric pumps are also in use, and there are quick running pumps in some of the mines even to deal with 11,000 gallons from a depth of 1,574 ft. In 1900 there were no less than 422 pumping plants, with a total capacity of 308,000 gallons per minute, capable of dealing with more than four times the in-flowing water.

(To be continued.)

FIG. 16. TRIPLE EXPANSION CONDENSING PUMPING ENGINE, GNEISENAU COLLIERY.
Raising 5,580 gallons a minute from a depth of 1,640 feet.

Ermak of 8,000 tons displacement and 10,000 horse power.

Discussing the design of icebreakers, the lecturer remarked that these vessels should have the bow angles and lines so arranged that when they had mounted the ice, and the ice was giving way under the vessel's weight they must not jamb when returning to be water-borne forward, always remembering that they were advancing and should remount the ice. When the ice was broken down it should pass along below the vessel or under the field ice, otherwise it lay on the water and had a tendency to jamb the vessel sideways, which resulted in the icebreaker having to smash a larger proportion of ice than was necessary, to give side clearance, thus absorbing more power, coal and time, and probably resulting in having to back and charge the ice. An icebreaker should also be able easily to turn out of the channel she had cut, and the form of the bow lines had much effect on that manœuvre.

The designs of icebreakers varied so much that there was no certain data to guide builders, but practice had shown that the full forward form, or spoon-shaped bow, was not successful in hard and packed ice, as the vessel pushed the ice in front of herself, instead of cutting and dispersing it. It should be borne in mind that icebreakers, when "charging" in heavy ice, were in collision, so to speak, during the whole time that they were at work, and that entailed much more strengthening of the bows and sides as the ice to be dealt with became more formidable. The shell plating must be considerably increased in small boats, and still more so as the vessels increased in size. Additional stringers, stronger decks, and a liberal addition to the number of bulkheads, transverse and longitudinal, as well as many pillars, became a necessity to prevent the constant recurrence of repairs.

All piping should be kept under the deck, and the fire pipes should be fitted with hydrants below and above that deck. The boiler-rooms must be well closed up, and consideration had to be given to the disposal of the ashes. The rudder should be arranged for easy unshipment afloat, and should be of large area and immensely strong. The moving parts of the machinery and the shafts must be extra strong and largely in excess of ordinary practice. On the engines it was preferable to have direct steam reversing gear, as the "all-round" type was a very heavy tax on the engineers when the ship was icebreaking.

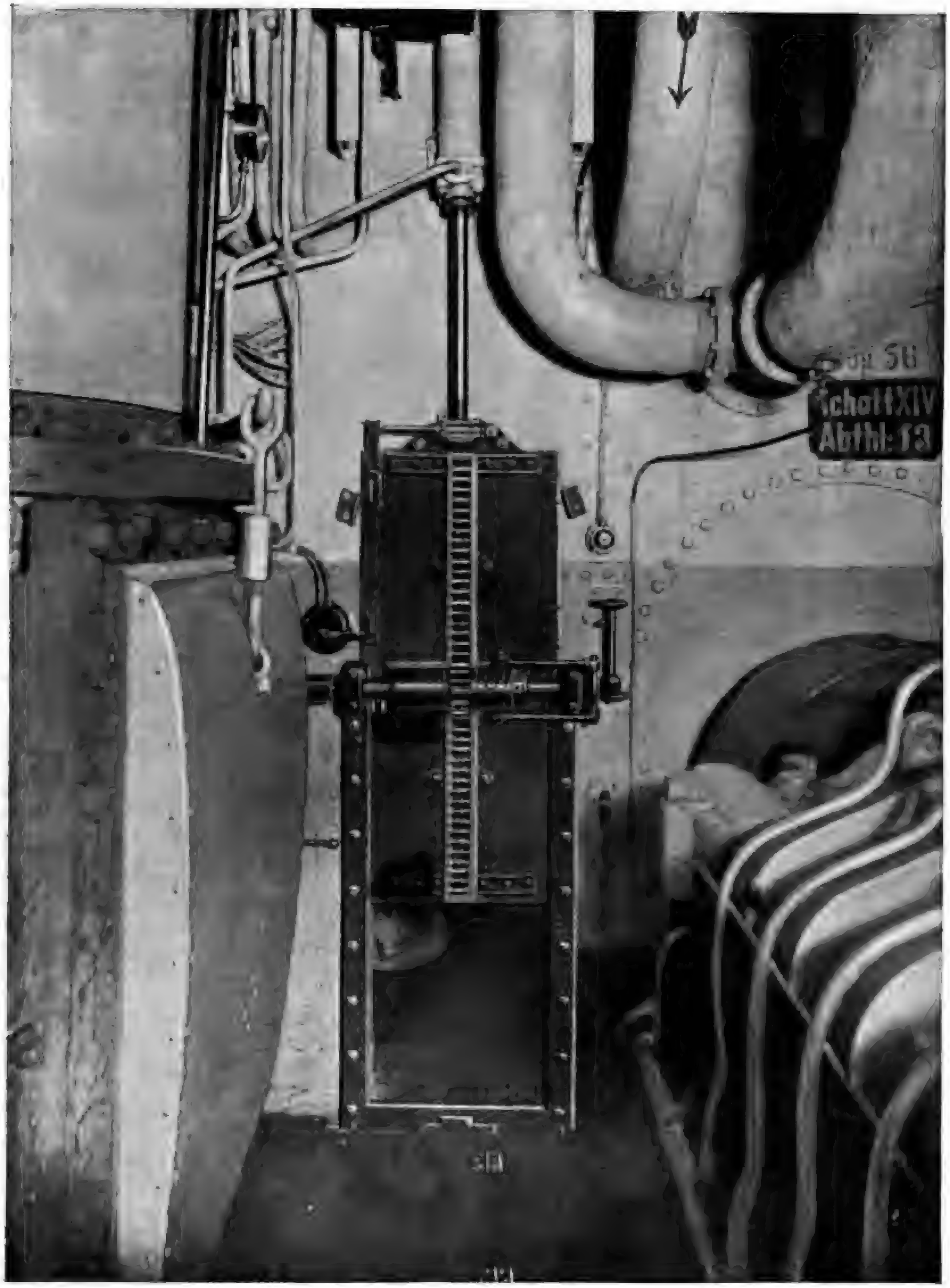
The vessel should be so designed that, if possible, she could be tipped to replace a propeller blade whilst afloat. The captain or icemaster had to exercise considerable care when cutting out vessels fast in the ice, and the procedure was to pass across the bow and then the stern of the fastened ship. Endeavours should be made to crack the ice in some direction towards the ends of the vessel before

FIG. 2. APPARATUS IN USE AT BEACHY HEAD LIGHTHOUSE.

The rotating apparatus is almost identical with that employed at the Lizard Lighthouse.

By the courtesy of the "United Service Gazette."

THE RUSSIAN ICE-BREAKER "ERMAK" FORCING HER WAY THROUGH THE ICE IN KRONSTADT HARBOUR.



VERTICAL SLIDING WATER-TIGHT DOOR ON THE STONE-LLOYD SYSTEM.

As fitted in the Imperial Mail Steamer " Kaiser Wilhelm II."

passing her in a parallel direction, so as to obviate, as far as possible, all chances of crushing the steamer's sides.

Among other vessels described by Mr. Gulston was the famous icebreaker Baikal, running on Lake Baikal, in the centre of Siberia. That vessel, he remarked, was built to connect the eastern and western ends of the Siberian Railway, which, as they knew, made a continuous railway from Ostend to Vladivostock in Eastern Siberia and Port Arthur in Manchuria. The distance of the ferry across the lake was 52 miles. The Baikal was built on the Tyne. The hull was completely erected, marked, taken down and shipped inside of six months, and 2,700 tons weight in 6,900 packages had to be transhipped across Siberia by boat to the place of re-erection. The boilers, of which there were 15, had to be kept under 20 tons in weight for transhipment purposes, and even those great pieces were moved in sledges by the aid of hand and pony power from the railway trucks to the ship. During the winter that enormous steamer had been at work she had proved herself to be most successful in keeping the service open under difficulties of ice navigation that were unknown, and therefore even unthought of, during her construction. There was, of course, no knowledge of the ice, as regards navigating purposes, on Lake Baikal until that vessel went to work.

The next vessel to be considered was the *Ermak*, built for Polar enterprise, as well as for icebreaking in the Baltic. The speed of the *Ermak* through 24 inches of solid ice, with 6 to 12 inches of snow on it, was 9 knots an hour, and she could charge and demolish packs of ice 20 to 35 feet thick. In Polar ice the speed had to be kept at about from 2½ to 3½ knots per hour, as one was apt to lose control of the vessel in that enormous ice, and the local shocks became very severe when she was charging about at her own "sweet will" amongst the Palæocristic ices. She had proved herself to be of enormous use on her station on the Baltic coast of Russia, where she could negotiate any ice and could safely bring out of danger all steamers that she went to assist. Indeed, in one season she rescued and assisted shipping of over £2,000,000 value, and in another winter she salved the Russian battleship Grand Admiral Apraxine, of £750,000 value.

With the *Ermak* in the Baltic there was no difficulty in Russia putting her fleet to sea, which usually wintered at Kronstadt, as the *Ermak* could easily guide them to open water should the necessity arise, and there was nothing to prevent that vessel herself being made into an armed cruiser.

WATERTIGHT BULKHEAD DOORS IN SHIPS.

The equipment of the German liner *Deutschland* with a complete system of watertight bulkhead doors on the Stone-Lloyd system, calls attention to an important development designed to render ships practically unsinkable.

In the event of a collision or other accident causing an inrush of water, it is, of course, a *sine qua non* that bulkhead doors should be capable of instant closing.

Past failures of bulkhead doors have arisen, in almost every case, from the length of time required to effect the closing at the critical moment. Hitherto the doors have had to be closed individually and mostly by hand. In cases where they were controlled by mechanism, the incompleteness of this mechanism caused the firemen and others working below the water-line, through dread of being shut up in a flooded compartment, or maimed by the unexpected descent of a water-tight door, to prop the doors open with wedges, thus rendering them useless in an emergency. The new system alters all this. The watertight compartments of the *Deutschland* have no less than twenty-four watertight doors, which are worked simultaneously from the bridge. A few seconds after the operation has been signalled by a warning bell, the whole of the doors can be lowered by the officer in charge. At the same time a mechanism is provided by which anyone imprisoned in one of the compartments is able to raise the door temporarily for his escape by lifting a lever. It then closes automatically. Should the officer fail to close the bulkheads it is claimed that any inrush of water would automatically effect the closing of the doors in the compartment or compartments affected; also that in the event of accident to the mechanism of the system itself, all the doors would close automatically.

As fitted in the Norddeutscher Lloyd's mail steamer *Kaiser Wilhelm II.*, and illustrated on the previous page, the installation consists of a hydraulic pressure main running the whole length of the ship, the pressure in which is maintained by means of an accumulator charged with compressed air and water by pressure pumps, one of which pumps air, and the other water, drawn from a tank, into which the exhaust from all door cylinders is connected. The pump, tank, and accumulator are placed above the water line, thus ensuring the closing of the doors, even should the compartment containing the pump, etc., be flooded. Instead of an accumulator, pressure may be taken from another source, such as from the feed pumps. The accumulator supplies pressure, by means of a main, to the bridge, from where it is diverted by means of a fourway cock into two other mains, used respectively for opening and closing all doors, by operating the valves accordingly, and supplying pressure to the hydraulic cylinders. An exhaust main is connected to all the hydraulic cylinders, and discharges into the tank from which the pressure pump supplies itself.

The working of the system from the bridge is effected by means of a small dial with two handles, one for closing and one for opening the bulkhead doors. The handle effecting the closing of the doors from the bridge is secured by a small wheel, which must be unscrewed before the handle can be moved. This proceeding occupies twenty seconds, and sets a warning electric gong ringing over every door. Immediately the handle is released it is moved to the left, by means of which pressure is put on the main, reversing the controlling valves and admitting pressure into the cylinders operating the doors.

SOME MODERN FIRE APPLIANCES.

BY

GEORGE ARMISTEAD.

The previous articles dealt with the work of the Fire Prevention Committee, and the principal English made fire appliances, as well as some important foreign engines and fire escapes shown at the Earl's Court Exhibition.—Ed.

III.

FIRE CALL SYSTEMS.

In group 3—Fire Calls—the gold medals fell to the General Electric Company, Ltd., the National Telephone Company, Ltd., the Siemens Electrical Appliances Company, Ltd., and Messrs. Siemens and Halske, Berlin.

The exhibits of the General Electric Company, Ltd., included apparatus of British design and manufacture throughout.

Their "Annunciator" switchboard in fig. 1, is specially constructed for installation in central fire stations. Among its principal advantages may be mentioned a discriminating buzzer for the purpose of distinguishing between real and accidental calls; it is also fitted with a complete set of telephone apparatus enabling the station to call up any office or department. All the parts are accessible for examination when required.

A watchroom type of switchboard has been constructed by the Company to the latest London County Council specification. This apparatus, intended for fixing in fire station watchrooms, is provided with an "on" and "off" switch, push button, and name plate for each fireman, and by arrangement of the connections it admits of the whole staff being called out or only individual members.

For street use a post is provided, as shown on page 158. This consists of a locking pull to be operated by

FIG. 1. THE "ANNUNCIATOR" SWITCHBOARD OF THE GENERAL ELECTRIC COMPANY, LTD.

THE GENERAL ELECTRIC COMPANY'S FIRE CALL SYSTEM AT WORK.

the public, and also a complete telephone set communicating with the station, so that the Brigade can at once proceed to the fire without losing time in calling at the point of alarm for instructions.

Another post of somewhat similar type is fitted with plug holes for plugging a portable telephone

FIG. 2. PORTABLE TELEPHONE APPARATUS BY THE GENERAL ELECTRIC COMPANY, LTD.

set, to be used only by the fireman or policeman on duty. This portable telephone apparatus is illustrated in fig. 2. It is of the collapsible type, and is carried by the fireman on his belt. This type of post can be seen in working order at Tottenham, Finchley, Penge, etc.

An ingenious fire and police alarm system which has been established at Liverpool, was exhibited by the National Telephone Company, Ltd., who were awarded a gold medal for their exhibit. Under this system street alarm boxes are fixed (to sides of buildings, or other suitable places) in all the important parts of the city, and connected with the nearest district police office. From each of these boxes six automatic alarm signals (having any meaning which may be desired) can be sent; for instance, "Patrol Wagon," "Horse Ambulance," "Fire," "Serious Fire," "Patrol Waggon B" (for cases where a number of constables are required), and "Telephone," together with the number of the box from which the call, or alarm is sent. These signals are recorded at the district police office by means of dashes and spaces, printed upon the tape of a recording instrument similar in design to an ordinary Morse telegraph inker. In each box there is a visual indicator to notify the person sending the alarm that the call has been received. This indicator is also used (by reversing the colour from red to white) to attract the attention of the constable on the particular beat in which

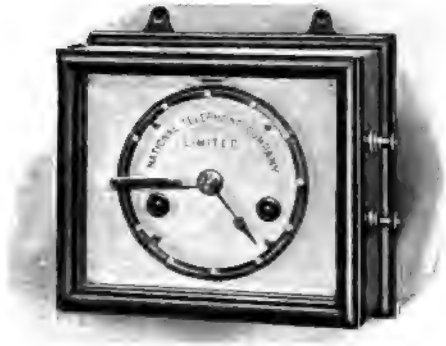


FIG. 3.

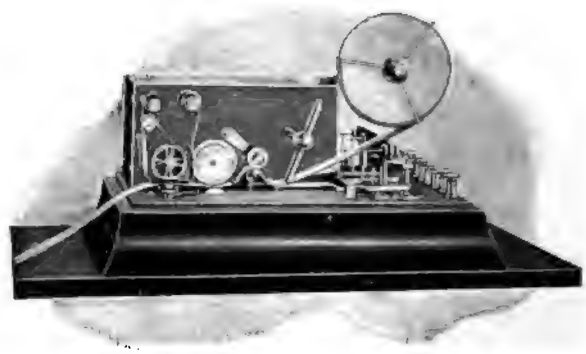


FIG. 4.

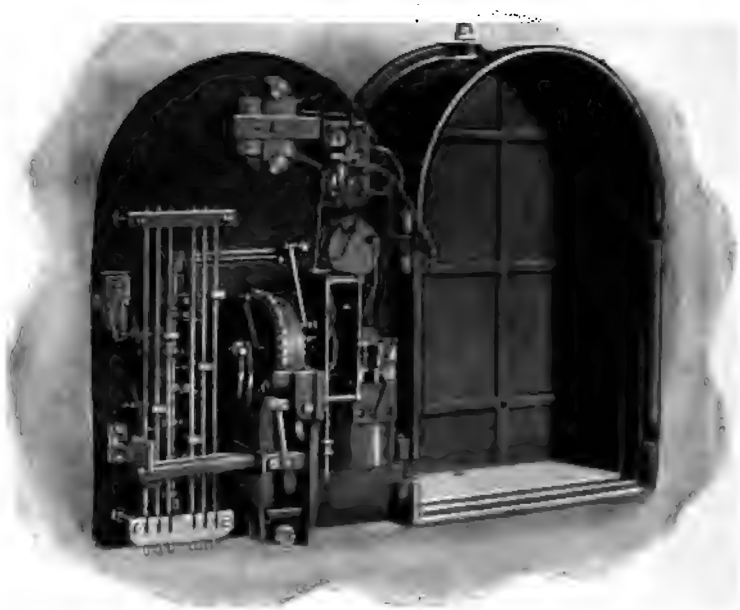


FIG. 5.

Clock (fig. 3), Morse Inker (fig. 4), and Alarm Box (fig. 5) used in the National Telephone Company's system.

[illegible] stated. He can then communicate [illegible] the office through the telephone fixed in [illegible].

[illegible] also an arrangement by which the constables [illegible] report themselves to the district police office [illegible] the different boxes they pass upon their beats. [illegible] accomplished by means of a special report key, [illegible] when placed in the key hole at the bottom of the box and turned once round, causes the number of the key used, together with the number of the box, to be printed on the tape of the recording instrument, also the time at which the signal is given.

Before an alarm can be sent the door of the box must be opened; this is done with a key of ordinary pattern, but which, when turned in the lock, cannot be withdrawn until released by a master key. The object of this is so that the person giving the alarm can be traced if necessary, the key being stamped with a number, and a record kept to whom it was issued. Inside the box are the six handles, or levers, each clearly marked. To send an alarm the handle marked with the signal required must be pulled down. This sets the mechanism of the box in motion, and causes the required signal and box number to be printed on the tape of the recording instrument at the district police office, also the time at which the signal is given. (See figures 3, 4 and 5.)

The alarm box, fig. 5, comprises cast-iron box fitted with mechanism, six transmitting levers and and a telephone set. The station outfit comprises a Morse telegraph inker with time stamp, and a clock. (Figs. 3 and 4. The inker acts as a receiver, the dashes sent by the transmitter being recorded on a tape.

TWO NOTABLE FIRE ALARMS.

Another prominent feature was the Pearson Fire Alarm System, which by the way, has recently been installed at the Mansion House. Under this system it is necessary in protecting a building to provide a number of automatic points, or thermostats which are fixed upon or around the ceiling, each thermostat covering a superficial area up to 400 square feet. For this purpose the well-known "Schoppe" thermostat is employed, the company having secured the sole rights in this invention for the United Kingdom and the Colonies. A pair of wires running throughout the building connect up the different thermostats with the automatic transmitter, which is placed at or near the street entrance of the building. A main circuit connects the transmitter with the central office or fire brigade station. An accidental breakage of the wire is recorded by a special signal, so that the system not only guards the building in which it is installed, but also automatically guards its own efficiency.

The Siemens Electric Appliances, Ltd., were also awarded a gold medal for their Automatic Fire Alarm System. The action of their automatic alarm depends upon the expansion of a liquid in a thermometer shaped tube, which, at a pre-arranged temperature, bursts the glass bulb. Their alarm, which is designed for both open and closed circuit working, is enclosed in a perforated metal cap and may be fixed in any convenient spot.

In the automatic alarm designed for open circuit working, the glass tube in its normal position keeps a spring from touching a lower contact, but as soon as the bulb bursts, the spring is released, the circuit closed, and one or more alarm bells actuated.

In the automatic alarm suitable for closed circuit working, on the other hand, the bulb of the glass tube presses two springs together, so that a current is always flowing through the circuit. With the bursting of the glass bulb, the main circuit is broken, and an alarm given on one or more bells.

It is claimed for the closed circuit that it is superior to the open circuit system, in so far as a constant control is kept over the whole installation. Indicators are also connected to their system to show in which part of the building an alarm has been given.

FIG. 6.—CUTTING UP JARRAH FOR SLEEPERS.

MATERIALS OF CONSTRUCTION.

This subject is one upon which volumes might be written. There can be no question but that the section of the Exhibition in which were shown so many samples of material designed to render outbreaks of fire presented an invaluable object lesson. Gold medals in the class for building construction were awarded the Columbian Fire-Proofing Company, Ltd., and Millar's Karri and Jarrah Company (1902), Ltd.

The exhibits of the latter company were designed to bring to the notice of engineers and others the suitability of Western Australian Karri (*eucalyptus diversicolor*) and Jarrah (*eucalyptus marginata*) for engineering works, street-paving, and all other purposes where hard wood is required. It is claimed for these woods that they possess the additional merit of comparative non-inflammability, and a section of a Jarrah pile was exhibited, which had been in use for thirty years in Bunbury Harbour, in order to show that it is proof against the ravages of the subaqueous attacks of the teredo or those of the white ant above ground. Other exhibits were designed to show the utility of these woods for railway work, more especially sleepers, timbering shafts, wood-paving, flooring, etc.

Fig. 6 shows the cross-cutting of a huge tree to sleeper length for South African railways. Sleepers of this wood were used for the Severn Tunnel throughout.

ELECTRICAL SAFEGUARDS

The Simplex Steel Conduit Company exhibited very attractively their fireproof system of conduits and fittings for safety electric wiring, the arrangement admirably illustrating how with a complete system of this kind the whole of an installation may be readily tested and inspected throughout by the removal of inspection covers. The tubes and fittings are, of course, incombustible and fireproof. On a board at the side were shown a sub-station code box and six thermostats connected up by Simplex conduit and fittings, illustrating the special adaptability of this system for electric fire-signal work. The conduits are made for socketed or screwed junctions, and are enamelled or galvanised, the brazed conduits or tubes being used for places where it is necessary that the wires are required to be in a water-tight encasement and watertight fittings in subways and such places where moisture is nearly always present. A switch with new special mounting made by this company is shown herewith, together with an inspection cross-piece. (Figs. 7 and 8.)

FIG. 7. NEW SWITCH, WITH SPECIAL MOUNTING.

FIG. 8. INSPECTION CROSS-PIECE.

We have only been able to take a cursory glance at a few of the more important exhibits, but enough has been said to indicate the valuable nature of the work done by the International Fire Prevention Congress, and the Exhibition. The question of fire prevention and extinction opens up more problems than at first sight appear. Those who wish to pursue the subject are advised to obtain the official report of the Congress.*

It includes many valuable papers by English and foreign experts, edited with conspicuous ability and admirably arranged for reference.

* "The Official Congress Report," with an Introduction by Edwin O. Sachs. Published for the British Fire Prevention Committee by *The Public Health Engineer*.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel Mining and Allied Industries.

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OUR MONTHLY SUMMARY.

LONDON, January 22nd, 1904.

For Apprentices and Pupils.

A carefully devised scheme has been issued by the Educational Committee of the North-East Coast Institution of Engineers and Shipbuilders, comprising regulations for apprentices and pupils which it is hoped may be generally adopted. By way of an immediate inducement for youths to voluntarily undertake "the severe discipline, self-denial, and hard mental work entailed by systematic study" in the higher branches of their profession, the scheme attaches increased pay to certain educational qualifications. Times have changed. The pursuit of knowledge had its own reward for some of us, but in these days students must have everything made easy for them, and we must also give them monetary inducements to go in and win. At the same time the principle of "payment by results" is involved in this scheme, and while it will materially help the industrious, it will automatically point out triflers.

Do We Work Hard Enough?

This is a question which is borne in upon us after a perusal of the clever series of articles lately concluded in the *Times* on the Industrial Conditions in Germany. Germany's success in commerce may be summed up in the one word—"work." A singularly solid and stable edifice has been built up by work—not in one or two directions, or by one or two classes, but work all round and from top to bottom, from the Kaiser to the workshop apprentice. The Government has always kept in view the duty of fostering industries, and the manufacturers have pushed resolutely forward, point by point, taking advantage of everything that might help them. The workmen have a less easy time than English workmen, and more to pay for a good living, but as regards actual well-being, the *Times'* commissioner has no hesitation in saying that in the mass they are better off. The difference is due partly to the habits of the people and partly to the institutions for preventing destitution, among which the Poor Law system and the State insurance are the most important. Do *we* work hard enough? It is a pointed question, and one which would seem to call for a great social preacher who would talk common sense to our working men, and make them realise that the individual makes the State, and that each owes it to the State to do his full share in the work of the world.

The New Year.

Turning from the shortcomings suggested by these articles, and putting aside the ever-present doldrums associated with our national drink bill, we can turn with relief to the expansion of our foreign trade. While stump orators are trying to persuade us that the British Empire is practically moribund, out come the Board of Trade Returns. There is no hysterical shrieking or playing of brass bands. John Bull, informed that the "foreigner" has "grabbed his trade," calmly produces a blue book, makes no comment, and leaves the man in the street to judge for himself. It is shown that during last year the value of the goods imported amounted to £542,906,325, as against £528,391,274, an increase of £14,515,051, or 2·7 per cent. of produce, and of manufactures exported during that period the value was £290,890,281, an increase

over 1902 of £7,466,315, or 2·6 per cent. The exports of foreign and Colonial merchandise have also increased £3,742,222 to £69,557,035, making the aggregate value of the foreign trade of the country £902,853,641. Surely this will serve to discount some of the pessimistic utterances of the time, and admit a cheerful anticipation of our operations in the New Year.

Belfast Shipbuilding.

Our congratulations are offered to Messrs. Harland and Wolff on their record year, an account of which will be found elsewhere. It is interesting to note that the increase in the output of the engine works has kept pace with that in the shipbuilding yard, the grand total being 100,400 i.h.p. This includes the engines for the battleship *King Edward VII*. The previous year's figures (which included the engines of H.M.S. *Queen*) showed a total of 60,200 i.h.p. Last year, therefore, gives an increase of 40,200 h.p., or 66 per cent. over 1902. Messrs. Harland and Wolff have shown themselves such adepts at beating their own records, that we shall look forward to their next year's record with a lively interest. A statement has been published to the effect that the firm have already received an order for a vessel exceeding the *Baltic* in size, but it has received official contradiction.

The Second Mosely Commission.

We are now awaiting with interest the report of the Mosely Commissioners. Mr. Mosely recently gave the following account of the American tour to an interviewer: We spent ten days in New York, and then visited Washington, where President Roosevelt gave us a reception and a most excellent speech; Hampton coloured schools, Baltimore, Philadelphia, New Haven, Niagara, Chicago, and Indianapolis, where our party split up. Some went further west to California, while a considerable portion, including myself, worked back east to New York, visiting Dayton and Pittsburg, Ohio, on the way. At every town committees met the delegates at the stations, formed them into groups, and conducted them to the various educational institutions. As a consequence they saw the maximum of work with a minimum of exertion and waste of time. Without anticipating the report of the delegates, I think I may say that they have brought home vast stores of knowledge as to what is moving the United States in its upward movement of industrial prosperity, and that educationally they have accumulated a vast amount of knowledge, which should be of great interest to the nation.

Mr. Wicksteed on Thorough Draughtsmanship.

The President of the Institution of Mechanical Engineers, whose article on the Evolution of the Chain appears in another part of the magazine, is a great believer in thorough draughtsmen. On a recent occasion he remarked that draughtsmanship was the A B C of mechanical engineering. He knew of many draughtsmen trained in Leeds who had gone to Russia, to France, and the United States, where they were getting 50 per cent. higher salaries than professors in shops where at least half a dozen professors were engaged. If men could afford to give their sons a four years' course at a university, by all means let them do so, but let that course be followed by at least a two years' course in draughtsmanship. If that were done, the student would be a better draughtsman, but the man who spent four years learning mechanical draughtsmanship would be a better man than he who had only spent four years studying at college.

The Chicago Fire.

Although the terrible theatre fire at Chicago has been shown to have arisen through a falling spark from a movable electric arc lamp, it by no means follows that the holocaust can be laid to the charge of electricity. Indeed, the application of the electric luminant has unquestionably minimised the risk of fires in theatres. A fireproof curtain that failed to act and exits that refused to open were chiefly at fault, and the whole sad affair should bring home to some of our London managers the fact that too much attention cannot be given to the comparatively small details that go to make up safety. Little things are often sufficient to cause great conflagrations. The fire at Exeter Theatre in the Jubilee year, when two hundred people perished, is a case in point. A broken window caused a current of air, which brought a portion of the scenery into contact with an insufficiently protected gas jet. The place was very soon a roaring furnace, and in twenty minutes the roof fell in. The loss of life was largely owing to inadequate exits, and this is where we think attention might with advantage be given in some of our London theatres.

The Late Sir William Allan, M.P.

A man of striking personality and character has been lost to the engineering world in the person of Sir William Allan. His views on the boiler question were of a pronounced order, and the fighting instincts which carried him through the American Civil War stood him in good stead in the House of Commons. Self-made and self-reliant, he was emphatically a man to admire. Like so many other hard workers, he found time to give to unexpected pursuits, and there was a poetic side to his nature which rendered him intensely human. A notable saying of the late knight was, that the world had been his chief educator, and men his books.

Is Business System Overdone?

One hears so much about system in these days that it comes almost as a shock to realise that it may be sometimes overdone. Mr. John Calder has been writing in one of the American journals on "The Use and Abuse of System," and there are several rules in regard to office and shop routine which he recommends managers to observe irrespective of the class of work done. They are as follows:—

1. Have a system definite and business-like in all departments.
2. See that a broad view of the subject is taken, and provision made for properly dovetailing the departmental systems.
3. Make the connection clear to all concerned by using graphic charts.
4. Have as *little* system and as few forms as possible. Make them a means, not an end. There are many needless items which are perpetuated, on card indexes and business forms to-day, in some systems.
5. Prune and pare the system till it gives economy, accuracy, and despatch in sales and manufacture.
6. Be always on the outlook for improvements but discriminating in adopting them.

It is emphasised that a system, like the plant itself, is worth no more than it can earn. All money, brain friction, and worry expended beyond this point are thrown away. Dead uniformity and absence of scope for individual initiative are not necessarily factors in securing what are the sole justification for special outlay on system—economy, accuracy, and despatch in sales, manufacturing, shipping, and installation.

NAVAL NOTES.

MONTHLY NOTES ON NAVAL PROGRESS IN CONSTRUCTION AND ARMAMENT.

BY

N. I. D.

GREAT BRITAIN.

TRIALS of battleships during the past two months have resulted in most cases satisfactorily. The *Queen* early in December last, at an eight hours' full-power trial, attained a speed of 18·4 knots. The revolutions averaged 116·4 starboard and 115·9 port, the gross i.h.p. being 15·556. The coal consumption worked out at 1·76 lb. per unit of power per hour.

In December, too, the *Prince of Wales* underwent a trial at one-fifth power attaining a speed of 10·45 knots, on a coal consumption of 2·2 lb. per unit of power per hour.

The *Hibernia*, which is one of the three battleships of the programme of the current financial year, was commenced at Devonport on January 7th.

In the armoured cruiser class there are several completions to report. The unlucky *Euryalus* has at last been put into commission, and with her the whole of the *Cressy* class of the programme of 1897–98 is completed. The *Euryalus* has gone to the Australian station. The *Monmouth*, of the *Kent* class, was commissioned on December 2nd for the cruiser squadron, the *Berwick* of the same class hoisting the pennant a week later. In November the *Bedford*, for the Channel fleet, and the *Donegal* for the cruiser squadron, were also put into commission.

The trials of the *Cornwall* have not at the time of writing been completed, but her preliminary runs are reported to have given satisfactory results. The eight hours' full-power trial of the *Suffolk* resulted as follows: Mean revolutions—starboard, 138·1, port, 139·3; i.h.p., 22,645; coal consumption, 2·2 lb. per unit of power per hour; speed, 24·7 knots, which s the best recorded speed for any vessel of the class.

The report which gained some publicity last October, to the effect that a new armoured cruiser of the *Duke of Edinburgh* type was to be built at Chatham, was at the time very generally discredited. The officials at the dockyard have now, however, been informed by the Admiralty that such a vessel is to be built there, on the slip which will be vacated by the *Devonshire* during February. No vessel of 480 ft. in length has previously been attempted at Chatham, the 450 ft. of the *Devonshire* having been up to the present as much as the slips there have been able to take. The armoured cruiser *Roxburgh* was launched on January 19th, the Duchess of Montrose performing the naming ceremony.

The *Diamond*, a third class cruiser of the *Amethyst* class, was launched from the works of Messrs. Cammell, Laird and Co., Ltd., of Birkenhead, on January 6th. This is the first vessel to leave the stocks since the amalgamation of the two firms Charles Cammell and Co. and Laird Bros. The *Diamond* is 360 ft. in length, and displaces 3,000 tons. With forced draught it is anticipated that she will develop 9,800 h.p., and attain a speed of 21·75 knots. Her boilers are to be of the modified Yarrow type, and for armament she will carry twelve 4-in. quick-firers and twelve smaller guns.

Contracts for thirteen of the destroyers of the programme 1903–04 have been divided as follows: Messrs. Palmer, at Jarrow, will build three, the *Swale*, *Ure*, and *Wear*, which are each to have four Reed boilers; Messrs. Hawthorn, Leslie and Co. will build three, the *Boyne*, *Doon* and *Kale*, which will have four modified Yarrow boilers each; Messrs. Cammell, Laird and Co. will build three, the *Liffey*, *Moy*, and *Ouse*, each of these being supplied with four Laird's water-tube boilers; Messrs. Yarrow will build two, the *Gala* and the *Garry*, each having four Yarrow boilers; while Messrs. Thornycroft are building the *Chalmer* and the *Colne*. These will each have four Thornycroft-Schultz boilers. Two more, at present unnamed, are, it is understood, to be built by Messrs. J. S. White, of Cowes, and supplied by them with White-Forster boilers.

The official trials of the *Blackwater*, built by Laird Brothers, have been completed. On the full speed trial the vessel maintained a speed for four hours' continuous running of 25·656 knots. She was run in a fully loaded condition. This is the fourth of the new type of destroyers built by Laird's which has completed her official trials, the first three vessels being the *Itchen*, *Arun*, and *Foyle*.

FRANCE.

Progress in the French Navy has not been very marked in the past two months. The event of the greatest importance was, of course, the launch of the battleship *Patrie* at La Seyne on December 17th. A vessel launched is not, of course, a vessel completed, especially in the French Navy, but it is at least a sign of progress, and as such is to be welcomed. The *Patrie* is of the *Republique* class, 439 ft. in length, 79½ ft. beam, and 27½ ft. draught. She displaces 14,927 tons, and is designed to attain a speed of 18 knots, with engines developing 17,475 h.p. It does not appear to have been yet decided as to what boilers she shall be provided with, both Belleville and Niclausse having been mentioned in this connection.

The boilers for the armoured cruiser *Jules Michelet* appear to have been decided upon, a modification of the grating surface in the Guyot boilers of the du Temple type having been approved by the Minister of Marine. The boilers will be twenty in number.

The *Marseillaise* has been commissioned for service in the Northern Squadron.

The *Admiral Aube* has finished all her official trials. On a run at full power of eight hours' duration, made

at Cherbourg on December 17th, the indicated horse power developed was 22,155, or 1,655 above what was required of her, with a speed of 21·9 knots. The coal consumption per indicated horse power per hour was 1·83 lb. at the rate of 34·3 lb. per square foot of grate area. The working of the engines and of the boilers of the Belleville type, with economisers, fitted on board of this ship, is reported to have been perfect.

The *France Militaire* states that the French Minister of Marine intends that experiments shall be carried out on the turrets of the new armoured French cruisers, *Gloire* and *Condé*, similar to those to which the fore turret of the *Suffren* was subjected a short time ago. On the occasion of these new experiments officers will take their place within the turrets in order to observe and report upon the shock effects produced when the turrets are struck by the shells fired upon them. It is known from experiments on shore that the shells, under the conditions imposed, will not be able to pierce through the armour of the turrets. Officers volunteered, but were not allowed to be within the fore turret of the *Suffren* when it was fired upon by the guns of the *Massena*. The *Gloire* and *Condé* are still at Lorient, where they were built, and where the *Gloire* has recently been undergoing her trials.

Two submarines, the *Ludion* and the *Estingeon*, were launched on January 7th and 9th respectively.

GERMANY.

Of the £5,160,000 for non-recurring expenses in the German Navy Budget for 1904, £3,385,000 is for shipbuilding, and includes the following items: A fourth and last instalment of £113,000 each for the battleships *Braunschweig* and *Elsass*, third instalment of £223,300 each for the battleships *Preussen* and *Hessen*, third and last instalment of £264,000 for the large cruiser *Roon*, third and last instalment of £52,300 each for the small cruisers *Hamburg*, *Bremen*, and *Berlin*, third and last instalment of £26,400 for reconstruction of battleships of the *Brandenburg* class, second instalment of £312,000 each for the battleships "M" and "N," second instalment of £241,000 for the large cruiser *Ersatz Deutschland*, second instalment of £116,850 each for the small cruisers "M" and *Ersatz Merkur*, second and last instalment of £72,000 for reconstruction of the large cruiser *Kaiserin Augusta*, and of £57,500 for reconstruction of the small cruiser *Irene*, first instalment of £124,750 each for the battleships "O" and "P," first instalment of £58,800 each for the small cruisers "N," *Ersatz Alexandrine*, and *Meteor*, first instalment of £38,400 for the gunboat "C," second and last instalment of £118,600 for a torpedo-boat division, and first instalment of £148,800 for a second torpedo-boat division.

Not a little satisfaction has been felt and expressed by the German public and the German press at the rapid completion of the second class cruiser *Hamburg*. The keel was laid in August, 1902, and on December 15th, 1903, the vessel was ready for commissioning. On her trials she made 23·3 knots with 11,000 h.p., exceeding the contract speed by 1·3 knots, and the contract power by 1,000.

RUSSIA.

The Franco-Russian works at St. Petersburg have secured the contract for the engines and boilers for the new Russian ironclad *Andreii Pervozvannui*; the boilers, twenty-five in number, are to be of the Belleville type.

According to reports the battleship *Tsarevitch*, on her way out to the Far East, accomplished several excellent steaming performances, and behaved very well in bad weather. Between Singapore and Port Arthur she did not touch at any port, and when eighty miles distant from the latter place, succeeded in getting into communication by wireless telegraphy. Her average speed for the whole journey was 10 knots, and during a continuous run of fourteen hours' duration she maintained a speed of 18·94 knots.

It is announced that the Ministry of Marine has under consideration plans for a new type of armoured cruiser, possibly that to which the three vessels of this year's programme are to belong. The displacement is stated to be 16,000 tons, and the speed 22 knots. The proposed distribution of the armament is noteworthy. All the 6-in. and 8-in. guns will be placed in ten armoured turrets, and the armour protected side will be very extensive. The vessels of this type are intended for service in the Far East.

Five new torpedo destroyers, to be named respectively *Grozni*, *Jivoy*, *Jivoutchy*, *Joutky*, and *Jark* have been laid down, and are to be hurried forward with all despatch.

UNITED STATES.

The trials of the *Maine* in November last were interesting, mainly because of the discussion on the merits and demerits of the Niclausse boilers with which that vessel is fitted. The *Maine* has twenty-four boilers grouped in three eights, having a grate surface of 1,353½ ft. and 53,343 square feet, of heating surface. Her engines are supposed to develop 17,348 h.p. On the trial no attempt was made to force the fires, and the committee, which was present during the trial to observe the results, reports that forced draught is unnecessary and undesirable, and should never be used for boilers of the class. The boilers gave no trouble, no difficulty was found in reaching 115 revolutions with the main engines, and there was a quick response to varying demands for speed. The coal used was 1,474 tons, and the average rate of combustion per square foot for the run north was 16·45 lb., and the average coal per indicated horse-power 2·45 lb. This was not satisfactory, but too many boilers had been lighted for the number of revolutions. The Committee insists very forcibly upon the importance of providing fresh water for all types of water-tube boilers, and is of opinion that the entire arrangements of the distilling plant and of the feed pumps must be altered if water-tube boilers of any design are to be a success. Evaporators should not be crowded into places so hot that men cannot give them the attention they demand. The boilers of the *Maine* are fine examples of mechanical work, and will require the services of men of intelligence and mechanical skill. The committee insist that the quality of the *personnel* is of greater importance than the quantity, and that water-tube boilers call for more brain work and less physical effort. Automatic feed devices were in use, but the Board says they cannot be trusted.

As a result of this trial it is announced that the Navy Board have decided to keep to the Niclausse boilers originally designed for the battleships *Virginia* and *Georgia*, and the armoured cruisers *Pennsylvania* and *Colorado*.

Bids have been solicited by the Navy Department for the construction of two 13,000-ton battleships, the *Mississipi* and *Idaho*. The maximum time allowed for the completion of the vessels is forty-two months. I have already given the main features of these vessels in these notes, and it is unnecessary to repeat them. The engines will be of the vertical twin-screw three-cylinder triple expansion type, fed with steam by eight water-tube boilers of a type yet to be decided upon.

Locomotive Engineering Notes.

BY

CHARLES ROUS-MARTEN.

Compound Locomotives.

Extreme as has been the slowness with which the compound principle as applied to locomotives has come into use in Britain since its modern initiation by Mr. F. W. Webb in 1882, there, at last, are symptoms—if one may judge from appearances—that the principle is to receive a more extended trial henceforth than it has hitherto enjoyed. So far, it must be admitted that the London and North-Western Railway and its late chief mechanical engineer have enjoyed an honourable, if regrettable, solitude as regards the compound crusade. Mr. Webb built his first compound locomotive some twenty-two years ago, completed at a cost not far short of £100,000, a first batch numbering thirty of the same type and class which, as express engines, have hardly been a success; and then constructed four successive batches of forty, ten, ten, and ten of express locomotives on the same principle, but of different dimensions, all having three cylinders —the first three of these batches proving distinctly efficient and useful. He also built a number of eight-coupled goods engines to his three-cylinder compound design. Then he suddenly and absolutely abandoned that design, and brought out instead a four-cylinder system, differing in virtually every main respect from its predecessor. It is now represented by eighty large express engines and a number of eight-coupled goods locomotives. That practically sums up the history of locomotive compounding on the only British railway that has systematically carried it out during a long term of years. The various sporadic experiments on the London and North-Western Railway with different types of compound tank engines may be neglected as not germane to the real inwardness of the present subject. At the present moment there has been reached, through the retirement of Mr. Webb and the appointment of his successor, a break in the continuity of the compound chain. That is to say, it is not yet known authoritatively outside the secret places of the Crewe offices whether the London and North-Western express locomotive, at any rate of the future, is to be compound or non-compound, and, if the former, whether of the four-cylinder or the three-cylinder type.

The London and North-Western "Alfreds."

It may reasonably be questioned whether Mr. Webb's final type of express compounding has even yet undergone a really fair test in actual service. The twenty engines which comprise that class, viz., No. 1941 "Alfred the Great," and nineteen others numbered consecutively up to 1980, were still in course of construction when the Traffic Department issued the much-discussed order that every London and North-Western express should be piloted if its load exceeded "17 coaches," reckoned on the basis of a twelve-wheeler representing 2 coaches, an eight-wheeler, 1½, and a six-wheeler or four-wheeler 1 "coach," and that this rule should operate irrespective of gradients, speeds, or other conditions. Now, an average 17-coach train on the London and North-Western Railway may be taken as weighing about 300 tons empty, or 305 to 320 tons including passengers, staff, luggage, and stores. I made a number of trials with these engines, and found them quite able to keep time with "17 coaches" even at fast bookings, but, of course, I had no chance of seeing what they could do with heavier loads in the ordinary service. Nor has it been possible to infer from their performances in association with a pilot engine what they could have done unassisted. *Prima facie*, it is difficult to understand why these more powerful four-cylinder compounds of the "Alfred" class should be deemed incapable of doing what a less powerful three-cylinder compound, *e.g.*, "Jeanie Deans," used to accomplish day after day. The heating surface of the newer type, 1,557 square feet, was manifestly too small to keep two 16-in. high-pressure cylinders adequately supplied with "live" steam at 200 lb. pressure. But, on the other hand, shortness of steam did not appear to be exceptionally common in their case.

New Valve Gear.

Assuming the Traffic Department's order for piloting with loads greater than 300 tons behind the tender to be justified by any ascertained shortcomings on the part of the new locomotives—which I distinctly do not assert as the result of my own experience—the question would naturally arise whether these elaborate and costly and fine-looking machines could not by some re-arrangement of design, be made more efficient. With this view, Mr. George Whale, the new chief mechanical engineer of the London and North-Western Railway, has devised a new duplex valve-gear, which is said to be giving results enormously superior to those obtained with the original gear. The special advantage of the new valve-gear is that it enables the cut-off to be varied at pleasure in each cylinder

independently of the other. The ability thus to employ an independent and different cut-off when this should seem advisable has always been recognised as one of the most valuable features of the de Glehn system of compounding. Mr. Whale employs only one reversing screw with which both the high-pressure and low-pressure valve-gears can be worked either together or separately, the variation being effected by means of simple mechanical modifications. The engine selected for experiment with the new valve-gear is No. 1952 "Benbow," one of the "Alfred" class. This particular engine had earned a certain amount of celebrity by the efficiency and regularity with which she ran the fast dining express to and from Birmingham, allowed 125 minutes for the 113 miles each way. On one occasion while fitted with the ordinary valve-gear, she made the up journey in exactly 121 minutes under my own observation, hauling a load reckoned as fourteen coaches. It will thus be seen that even with the original valve-gear, "Benbow" acquitted herself creditably, although of course neither was the load really heavy nor the speed specially high. But during experiments which were officially made between Crewe and Stafford in each direction with the new valve-gear, the superiority of her working was remarkable. For example, taking unaided a train weighing 372 tons behind the tender, "Benbow" ran from the Crewe start to the Whitmore Summit, 10½ miles, in 18½ minutes, averaging 34 miles an hour, and reaching a maximum speed of 40, whereas with her original valve-gear, the 10½ miles occupied 22 minutes, averaging 28·6 miles an hour, and the highest speed she could attain up the bank was 34. The work in the opposite direction is less noteworthy because the so-called "bank" is so very easy that it would ordinarily be regarded as almost a level stretch, the greater portion being no steeper than 1 in 2,105 to 1 in 505, while only for three miles immediately preceding the summit is it so steep as 1 in 391 and 1 in 398. Here, also, however, the better results of the new valve-gear made themselves prominent, the average uphill speed being 43 miles an hour, and the maximum 52, as against 37·3 and 45 with the old gear. Moreover, the maximum indicated horse-power, which was 814 one way and 756 the other with the old gear, was 940 and 949 respectively with the new. These figures speak for themselves, and afford reason to hope that with the aid of the new valve-gear these fine-looking engines may ere long be able to prove unwarrantable the reproach that they are unable to do without assistance the work for which they were specially designed and built.

The Tri-Cylinder Midland Compounds.

At present it certainly would appear that the tri-cylinder express compounds designed and built by Mr. Johnson on Smith's system for the Midland Railway are likely to prove a permanent institution. Whatever theoretical objections may be taken to the employment of three cylinders instead of four, it would be unpractical and unscientific also to allow undue weight to these in the face of the results of actual experience. It is undeniable that much of the disadvantage attaching to the use of only three cylinders is materially mitigated when the driving-wheels are coupled, while it is accentuated when the different pairs of driving wheels are worked independently. How far the success of the Midland compounds may be due to the fact that London and North-Western practice is reversed in another particular, namely, the use of one instead of two high-pressure cylinders and of two instead of one low-pressure, is a question upon which much diversity of opinion exists, and upon which a great deal may be said both *pro* and *contra* each method. What seems to me more to the point, in the view of the results attained, is the relative proportion adopted between the cubical capacities of the high-pressure and low-pressure cylinders. In Mr. Johnson's engine the single high-pressure cylinder is 19 in. in diameter. That is equivalent, roughly, in cubical capacity to two separate cylinders each 13½ in. in diameter. In Mr. Webb's engines there are two high-pressure cylinders, each 16 in. in diameter, and two low-pressure 20½-in., while Mr. Webb provides a boiler having 1,557 square feet of heating surface against Mr. Johnson's 1,508 square feet. Thus, Mr. Webb provides somewhat less boiler power with considerably more high-pressure cylinder capacity. It may be observed that Mr. Johnson's cylinder ratios approximate those with which M. de Glehn has achieved such remarkable success. And when we come to the practical outcome we find that, whereas in the London and North-Western case it has been deemed necessary to adopt certain stringent limitations of load in consequence of complaints made of unpunctuality, in the other two cases we see the engine successfully taking loads hitherto unheard of as worked by one engine at anything like such high-booked speeds, and doing so with a degree of success that appears absolutely without qualification. It is legitimate to hope that as altered by Mr. Whale, the North-Western compounds may yet give full satisfaction. Meanwhile, Mr. Johnson may be congratulated upon the success which has from the first been attained by the engines of his design. The case is purely one of judging a tree by its fruits.

The North-Eastern Colossus.

The enormous "Atlantic" engine which Mr. Wilson Worsdell has designed and built at Gateshead for the heavy express service of the North Eastern Railway, could not be got ready so soon as was anticipated. Owing to unavoidable delay in obtaining certain necessary materials, her construction was materially retarded, and the engine did not come out until just before the end of the year. The principal dimensions of this vast engine were given in the August issue of PAGE'S MAGAZINE, page 171, and it will doubtless be remembered that they represented an engine far larger and heavier than any other of the four-coupled class hitherto seen in Great Britain. In view of the very fine work performed under my notice by its immediate predecessors, Nos. 2101-2110, of which it is virtually an enlarged development, there seems no reason to doubt that the North Eastern "Atlantic" will afford something like finality in the long effort to secure an engine that will grapple adequately with the latest requirements of the North Eastern's heavy express service. Two or three of the new "Atlantics" are now out and are taking their part very satisfactorily in the ordinary winter express work. This, however, manifestly affords no true test of their capacity, which will not be thoroughly brought to trial until they have to take their part in running the very heavy summer expresses of the coming season. These, even since the introduction of the "2001," "2011," and "2111" classes, have hitherto required the occasional use of an assistant engine, but it may reasonably be hoped that Mr. Worsdell's new colossi will render piloting a mere "memory of the past" on the North Eastern Railway.

SHIPBUILDING NEWS.

BY

"SHIPBUILDER."

IT was predicted here last month that when the shipbuilding returns for 1903 were completed it would be found that the total would probably turn out as much as 200,000 tons short of that of 1902. This, of course, referred to the output of the United Kingdom, which is now seen to have been 1,409,630 tons, as compared with 1,616,235 tons in the previous year—a decrease of no less than 206,605 tons, which is rather greater than our estimate. It is evident that there was even more inactivity in the English yards than was supposed, for the Scotch total (on the returns of the *Glasgow Herald*, whose figures are carefully compiled) was 484,853 tons, as compared with 566,553 tons, a decrease of only 81,700 tons. At the end of November the Scotch record was 85,000 tons short, but there was a considerable output in December to reduce the difference. The output of the British Colonies was 37,225 tons, as against 24,700 tons. In so far as returns have been received from foreign countries, the output of the rest of the world seems to have been 1,232,676 tons, as against 1,074,735 tons in 1902. But we do not present these last figures as conclusive, or as proving an actual increase in the foreign production. The 1902 figures we know to be defective, and those for 1903 we do not recognise as perfect.

World's Output.

The following tabulates the whole world's output of new ships :—

	1903. Vessels.	1903. Tons.	1902. Vessels.	1902. Tons.
Scotland	362	484,853	404	566,553
England	871	766,295	937	891,109
Ireland	25	158,482	27	158,573
United Kingdom total ...	1,258	1,409,630	1,368	1,616,235
Colonies	[illegible]	37,225	86	24,700
Foreign	1,087	1,232,676	939	1,074,735
Grand total ...	2,441	2,679,531	2,393	2,715,670

The United Kingdom, it will be seen, has a larger tonnage than all the other countries of the world combined, including even the British Colonies.

I.H.P.

The above includes both sailing ships and steamers, but with regard to the latter the following has been the—

WORLD'S OUTPUT OF MARINE ENGINE POWER.

	1903. i.h.p.	1902. i.h.p.
Scotland	497,396	510,808
England	727,221	669,368
Ireland	128,450	107,100
Total, United Kingdom ...	1,353,067	1,287,276
Colonies	12,966	10,815
Foreign	986,452	719,163
Grand total ...	2,352,485	2,017,254

Here, again, the United Kingdom beats the rest of the world.

The Work of the Year.

The actual number of vessels launched all over the world during 1903 was, according to these returns, 2,441, with a tonnage of 2,679,531, and an indicated horse-power of 2,352,485. In 1902 there were returns of 2,393 vessels of 2,715,670 tons and 2,017,254 indicated horse power. The number of vessels in 1903 was thus more by 48, the tonnage less by 36,139 tons, and the indicated horse power greater by 335,231. More than half of the tonnage was produced within the United Kingdom, England turning out 871 vessels, of 766,295 tons; Scotland, 362 vessels, of 484,853 tons; and Ireland, 25 vessels, of 158,482 tons. With the exception of the United States, no foreign country launched an aggregate tonnage equal to the Clyde, viz. :—277 vessels, of 446,869 tons. There was a decrease on the Clyde, the Tay, the Dee, the Tyne, the Wear, Tees and Hartlepools, the Thames, in Ireland, Germany, France, and Holland; and an increase on the Forth, the Mersey, the Humber, the English Channel, in the Colonies, the United States, Russia, Norway and Sweden, Italy, Austria-Hungary, Japan, Denmark, Belgium, and China.

Scotch District.

The following table shows the number, tonnage, and indicated horse power of vessels produced in Scotland during the year. There is a decrease in each section, of 42 vessels, 81,800 tons, and 13,412 i.h.p. :—

	1903. Vessels.	1903. Tons.	1903. i.h.p.	1902. Vessels.	1902. Tons.	1902. i.h.p.
The Clyde	277	446,869	455,221	312	516,677	458,870
The Forth	30	15,356	13,445	38	12,890	12,260
The Tay	19	16,223	19,460	29	24,255	28,800
The Dee	36	6,405	9,300	25	12,431	10,878
Total	362	484,853	497,396	404	566,553	510,808

English Shipbuilding.

And the following tables, compiled from the reports from English shipbuilding districts, show a reduction on the year's output of 65 vessels, 124,814 tons, and an increase in the indicated horse power of 57,853 :—

	1903. Vessels.	1903. Tons.	1903. i.h.p.	1902. Vessels.	1902. Tons.	1902. i.h.p.
The Tyne	149	262,794	254,405	144	324,487	277,960
The Wear	60	189,339	137,465	67	230,277	150,453
Tees and Hartlepools	67	171,304	89,640	74	192,709	111,600
Mersey to Solway ...	80	55,705	89,401	67	28,502	19,165
The Humber	125	31,065	36,510	120	26,457	24,135
Royal Dockyards ...	4	28,290	1,400	5	51,560	12,500
The Thames	195	18,494	98,016	306	29,104	51,129
English Channel ...	181	8,550	18,554	147	6,950	12,821
Bristol Channel ...	10	754	930	7	1,063	605
Total	871	766,295	727,221	937	891,109	669,368

Irish Shipbuilding.

The following is the Irish record :—

	1903. Tons.	1902. Tons.
Harland and Wolff	110,463	78,950
Workman, Clark, and Co. ...	44,738	75,430
Londonderry Co.	2,188	3,354
Dublin Co.	605	430
Larne Co....	380	400
Palmer, Cork	108	—
	158,482	158,573

The most notable return in the shipbuilding year is that made by Messrs. Harland and Wolff, who have made a tonnage output of over 100,000 gross tons, and 100,000 i.h.p. The position attained by this firm is unique in the annals of shipbuilding. They have again placed in the water a vessel for the White Star Line—the *Baltic*—largest in the world's list of large vessels. This return is noticed elsewhere. The output of this firm for the year consisted of eight enormous vessels, seven of which were full-powered passenger and mail boats, or combined passenger and cargo boats of exceptional size. The eighth was H.M. yacht *Enchantress*—3,540 tons displacement—built entirely to Messrs. Harland and Wolff's own designs.

Largest Builders.

The leading shipbuilders in 1903 were as under according to their tonnage :—

	Vessels.	Tons.
Harland and Wolff (Belfast)	8	110,463
Swan, Hunter, and Wigham Richardson (Tyne)...	22	61,589
John Brown and Co., Ltd. (Clyde)	6	55,152
Armstrong, Whitworth, and Co., Ltd. (Tyne) ...	13	48,740
Russell and Co. (Clyde)	13	45,810

In 1902 the order of the first six firms was :—Harland and Wolff ; Workman, Clark and Co.; Swan and Hunter ; Russell and Co. ; Armstrong, Whitworth and Co. ; and Wm. Doxford and Sons.

In marine engineering the leading firms in 1903 were :

	i.h.p.
Harland and Wolff	100,000
The North-Eastern Marine Company (two shops)	89,275
John Brown and Co., Ltd.	61,000
Richardsons, Westgarth, and Co. (three shops)...	55,010

In 1902 the North-Eastern Marine Company were first, and were followed in their order by Messrs. Richardsons, Westgarth and Co. ; Messrs. H. and W. Hawthorn, Leslie and Co. ; the Wallsend Slipway Company ; and Messrs. Harland and Wolff.

Foreign Shipbuilding.

The following summary table of foreign shipbuilding returns shows an apparent increase in the number of vessels launched and of indicated horse power produced in foreign countries in 1903, as compared with 1902. The increases are most pronounced in the United States and Russia :—

	1902 Vessels.	1902 Tons.	1902 i.h.p.	1903. Vessels.	1903. Tons.	1903. i.h.p.
United States ...	188	493,144	324 290	162	325,678	172,528
Germany	271	261,003	107,225	259	269,755	232,287
France	71	107,431	70 107	102	192,300	81,208
Holland	180	71,423	49 233	170	92,067	34,010
Russia	40	63,726	124,163	15	2,743	19,035
Norway and Sweden	94	61,057	45,262	67	42,303	30,054
Italy	62	52,380	24,976	26	50,030	34,426
Austria-Hungary ...	34	37,208	24,515	26	21,233	22,455
Japan	59	35,411	91,096	48	35,032	64,120
Denmark	20	23,849	21 500	20	22,198	14,020
Belgium	18	17 301	7,570	14	15,332	7,195
China	45	6,631	5,085	22	3,824	5,875
Spain	1	2 040	—	1	2,040	—
Greece	4	72	530	1	200	150
	1,087	1,232,070	986 452	939	1,074,735	719,163

In some cases in the above list warships are included, and in other cases are not. The comparison is with a total of 939 vessels, and 1,074,735 tons in 1902, which, however, did not include warships built in Russia, and was otherwise imperfect.

British Comparison.

The principal shipbuilding districts in Britain, grouped along with the leading foreign countries, again show the predominance of the United Kingdom. If steamers only were taken into account the preponderance would be greater still, as much more of the Continental than of the home tonnage is made up of sailing vessels :—

	Vessels.	Tons.	i.h.p.
United States	188	493,144	324,290
The Clyde	277	446,869	455,221
The Tyne	149	262,794	254,405
Germany...	271	261,003	107,225
The Wear	60	189,339	137,465
Tees and Hartlepools	67	171,304	89 640

A New Coal Carrier.

Among the notable productions of the year was *Hedwig Heidmann*, built by Sir Raylton Dixon and Co., Ltd., Middlesbrough, for carrying coals from the Scotch collieries, on the Firth of Forth, to Hamburg, and especially adapted for this trade by several peculiarities of construction and outfit. The most remarkable feature is that for size she will carry more water ballast than any other ship afloat, amounting in all to over 1,400 tons. This is carried in such a position that she will be remarkably easy in heavy weather, the propeller being always submerged in either light or loaded trim. The upper structure is so designed that the inner shell plating and frames are carried up to the deck in a diagonal line fore and aft, and a superstructure is built on this containing the water ballast, carried to the side of the vessel, thus making her very strong. In outer appearance and space for discharging cargo and working the ship she is like any ordinary vessel. The cargo holds have been so arranged that they are free from any obstruction, such as beams and pillars. She is designed to discharge a cargo of over 3,000 tons in eight hours. This is the most efficient and economical type of steamer yet built specially adapted for coal, grain, and ore. The net register of such a vessel may be less than one-third of the dead weight—*i.e.*, the ship will carry a 3,200 deadweight cargo of coal on a net register of about 1,000 tons. This constitutes the lowest register of any description of full-decked ship.

Yacht for the Sultan.

From the Elswick shipyard the yacht *Erthogrea*, destined for the Sultan of Turkey, was recently launched. It has a length between perpendiculars of 260 ft., and a displacement of 900 tons.

THE CIVIL ENGINEER AT WORK.

By C. H.

The New Tube

London's latest tube connects Finsbury Park Station on the Great Northern Railway with Finsbury Pavement in the City, a distance of about 3½ miles, the intermediate stations being Drayton Park, Highbury, Essex Road, and Old Street. The line is for the most part conducted underground in two tubes, the most extraordinary feature of the new line being the increased diameter of the tunnels, which are 16 ft. wide, opening out to nearly 23 ft. in diameter at the stations. This renders possible the admission of ordinary rolling stock. The accompanying illustration, from the *Light Railway and Tramway Journal*, shows the diameter of the tube as compared with those of the Central London, and other railways. Everything is of a larger scale than in the tubes to which we have already become accustomed, and while greater width and ample proportions of the stairs and passages have been ensured, it is anticipated that the new tube will score in the direction of ventilation. In order to minimise the amount of noise and vibration, a vitrified blue brick invert supporting the iron roof has been largely employed. The trains will be equipped with the multiple unit system of the British Thomson-Houston Company, Ltd., which will admit of the trains being operated in either direction from either end. The power is supplied from a single generating station in Poole Street, New North Road, and by this arrangement it will be possible to operate the line without feeding from any other point.

It is proposed to run a three-minute service of seven coach trains, the single journey being completed in about 13½ minutes, including three intermediate stops of twenty seconds each. The trains will be worked on the shuttle principle at the termini, thus avoiding shunting, and it is intended to complete the double journey in thirty minutes. With this service there will be eleven trains running. Each train, which weighs about 200 tons when normally loaded, has a seating capacity of 505 passengers, and is composed of three motor cars and four trailers.

The engineers responsible for the work are Sir Douglas Fox and Mr. Francis Fox. The contractors are Messrs. S. Pearson and Son, the British Thomson-Houston Company, Ltd., being responsible for the electrical equipment, power house, line, and rolling stock.

All structures connected with the tube are fire-proof, not excepting even the signalmen's cabins, and the platforms are of solid concrete and iron. Every care has also been taken in dealing with the electrical equipment to make the fireproofing a matter of primary importance, and an independent lighting system is supplied throughout the tunnels.

London has now to look forward to a conversion of the Metropolitan Railway and the completion of the Baker Street and Waterloo, and the Charing Cross and Hampstead Railways.

The Cape to Cairo Railway.

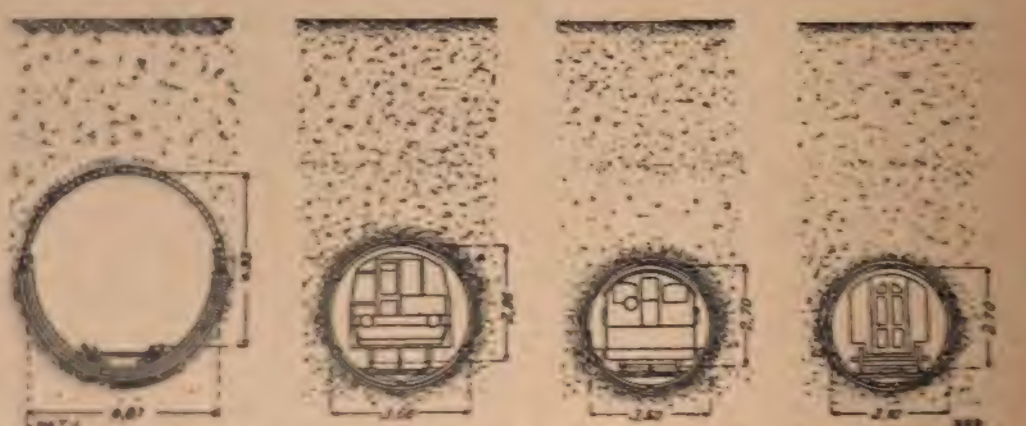
Discussing progress in Africa in 1903, the American *Review of Reviews* remarks that the French engineers are constructing railways and opening trade routes in the African regions under their control. It is to be remarked, moreover, that the French have just completed a railway across their great African island dominion of Madagascar. The Belgians also are doing some remarkable railway building in the Upper Congo country. The British line northward from Bulawayo is already within a few miles of the Zambesi River, which forms the northern boundary of what is known as Rhodesia; and doubtless within a very few years the line will be advanced across British Central Africa to the boundaries of the Congo Free State. Thus Mr. Rhodes' great conception of a connected rail route from Cape Colony to Cairo will in due time be realised.

Indian Irrigation.

The Indian Navigation Commission report that there is a wide but not unlimited field in which the engineers and civil officers can work together for the protection of the country from famine; partly by the construction of new State irrigation works, and partly by encouraging and stimulating the extension of irrigation by means of private works. Both methods will involve heavy expenditure on the part of the State, upon which there will be no direct return, although it may be justified by the value of the protection afforded.

The New Dock at Llannelly.

The Llanelly North Dock, which was begun in March, 1898, has now been thrown open. The construction of the dock has occupied about two years. It is nine acres in area and has a depth of 28 ft. The cost was nearly £250,000, the contractor being Mr. L. P. Nott, of Newcastle.



Gt. Northern and City Tube, 3·5 miles, diam. 16 ft. — Waterloo and City, 1·5 miles, diam. 12 ft. — Central London, 6·5 miles, diam. 11 ft. 8 in. — City and South London, 6 miles, diam. 10 ft. 6 in.

POWER STATION NOTES.

By "ELECTRICAL ENGINEER."

The Simplicity of Transmission Plants with Pelton Wheels as Prime Movers.

In the Colonies there are many towns which will some day wake up to the possibility of using the power of a neighbouring fall, for water power is, in a sense, perpetual motion, as its continuous use exhausts none of the resources of nature. Manufacturers would do well, therefore, to lay themselves out to supply the plant at a reasonable price, and of the right kind for the work, for it is good paying business. It is really wonderful how easy to run a three-phase transmission plant may be made, especially when the prime mover is that wonderfully simple and cheap form of apparatus—the Pelton wheel. The writer calls to mind a plant for the East, where the machinery arrived during the wet season, when the roads were impassable. Nothing daunted, however, the native workmen took to pieces the Pelton wheel and its governor, the alternator including even the armature core plates, and also all the other machines, motors, pumps, etc., and carried the whole about a hundred miles up country. The plant was entirely erected by unskilled black labour, and worked without a hitch from the commencement. In the case of another larger multiphase plant for the Straits Settlements, this also was laid down by a single white engineer, assisted mainly by Chinese, and here again the whole thing went from start to finish without a single hitch. The writer very much doubts whether, if the generating plant had been steam and the electrical machinery of the continuous current type, the same results would have been obtained. Multiphase electric generators and motors, etc., are about as reliable as machinery can well be, and if it is possible to use Pelton wheels for generating the power, then the whole plant attains a simplicity quite unique, and just the thing for outlandish places, where skilled labour is scarce.

Pelton Wheel Governors.

The one tricky feature of a Pelton wheel is the governing device, for water under high heads is somewhat difficult to control on account of the great pressure. Thus, at 1,200 ft. head the pressure is over 520 lb., and with a 27 in. diameter steel pipe $\frac{11}{16}$ in. thick the bursting stress is nearly five tons per square inch, giving a factor of safety under normal pressure due to the head alone of 5 to 1. Now the inertia of a column of water moving rapidly through a long pipe is so enormous that any attempt to even partially shut off the water suddenly would certainly burst the pipe. The governing of the Pelton wheel must therefore be arranged so as to avoid any shock to the pipe line.

There are three methods of governing under high heads. The first is by means of stand pipes, to which the flow of water is diverted when shut off from the wheel, relief valves being also provided. The second, which is used largely in the States, is to deflect the jet or stream away from the buckets, the increase in speed of the centrifugal governor throwing a nozzle deflecting mechanism into action. The third is a method recently introduced by Mr. E. F. Cassel. In this system the wheel is divided along the centre line of the buckets into two sections, and the centrifugal force developed in the rotation of the wheel body itself is arranged to cause the two sections to separate slightly. A portion of the water jet is thus allowed to pass between the buckets, instead of impinging directly against them. Being part of the wheel itself, the governing action is instantaneous; it is self-contained, and has only four moving parts.

Of course, in the above the writer has been considering governing for sudden changes in load. Where the load is reduced or increased permanently, then the water can be *slowly* turned off or on, without danger, either by hand or by an additional governing device.

Expansion of Steel Pipe Lines.

One of the problems in connection with laying down steel-pipe lines for power purposes is the question of expansion. For example, with a difference of temperature of 100 degrees Fahrenheit, a steel pipe 100 ft. long will lengthen $\frac{3}{4}$ in., which means that a straight pipe a mile long will extend over three feet. Fortunately, when working under ordinary conditions with the pipe full of water, the difference of temperature is not likely to be so much as 100 degrees Fahrenheit, especially where the water is taken from a lake or mountain torrent. Again, the pipe is usually laid in a trench in the ground and covered with turfs, leaving only the joints exposed. This has also the advantage that the pipe is not so great an eyesore in the landscape. In the case of the Coolgardie pipe line, which, it may be mentioned, is 200 miles long, an ingenious method of keeping the temperature down is by whitewashing the line at frequent intervals. This method, of course, can only be adopted where appearance need not be considered, and in any case it is scarcely required except in tropical countries.

The expansion of the Coolgardie line is provided for by spigot joint rings, invented by Mr. Mepham Ferguson, having lead caulking. Messrs. Piggott and Co., the well-known Birmingham firm, use flanged pipes, and take up the expansion by inserting at intervals a short piece of corrugated pipe, somewhat similar to a corrugated boiler flue. The corrugations are liable to increase the water friction, but this can be obviated by inserting a thin steel liner inside the pipe.

ERRATUM.—On page 81 (January issue), first column, third paragraph, under the heading "Vertical *v.* Horizontal Water-Tube Boiler," read : "In the vertical type the feed-water enters the rear steam and water drum, passing down the rear bank of tubes," etc.

VERTICAL *v.* HORIZONTAL WATER-TUBE BOILERS.

THE remarks under the above heading in our January number must, of course, be taken as representing the point of view of the manufacturer of the vertical type boiler, and the statements were naturally *ex parte* ones.

To enter into a controversy as to the relative merits of horizontal and vertical water-tube boilers would occupy far too much space, and the subject has already been thrashed out in other technical journals.

The fact also that one firm of horizontal water-tube boiler manufacturers has already nearly 4,500,000 h.p. at work shows that these makers have, at all events, good arguments in favour of their type of construction.

To avoid misconception on the part of our readers, we would draw attention to the statement on page 162, that we do not necessarily share the views expressed by individual contributors, and it is only fair to point out that we dissociate ourselves entirely from the opinions expressed in the January number by the writer of "Power Station Notes."—ED.

ELECTRICAL AFFAIRS.

BY

E. KILBURN SCOTT, M.I.E.E., A.M.Inst.C.E.

Skimping of Spindles and Bearings.

The other day the writer's attention was drawn to an electric motor, which was satisfactory from the electrical point of view, but which had been most unwisely skimped in the mechanical details. It was, indeed, a technical school graduate's design, and the bearings in particular were quite out of proportion.

It is strange that manufacturers should cut down the bearings and spindles of electric motors, for the bulk of the money spent on these parts goes in the machining. It makes very little difference in material whether the bearing is 1¼ in. by 3 in., or 1½ in. by 4½ in., and the labour in the two cases would be about the same.

Again, some electrical motors have very small oil reservoirs under the bearings. In order that a motor may run for several weeks on end without attention, The oil reservoir must be of ample dimensions and the oiling ring dip well down below the surface, for when running the oil level drops considerably. Every care should also be taken to see that the oil-throwing rings and the recessed portion at the end of each bearing are of ample size to collect the oil properly and pass it back to the oil reservoir.

Rating of Motors and Starting Switches.

Amongst the many urgent matters which require attention at the present time is some system of rating electric motors and starters. On the Continent electric motors are divided into three classes, rated according to the nature of the load for which they are intended. Thus motors for *intermittent use* give the full horse-power stated on the output plate for one hour ; those for *short-time use* have to give the full load for two or three hours, followed by a period of rest ; and those for *continuous use* must give the full horse-power for ten hours without overheating. A good deal of the misunderstanding between contractors and customers in the matter of supplying motors for factory driving is due to the fact that we have no proper system of rating. Similarly, motor starters ought to be rated into those for *occasional use* that is, where the resistance can cool down, as, for example, where the motor is simply switched on after each meal-time ; those for *frequent use*, where the motor is continually being switched on and off, as is the case when driving machine tools; and those for *continuous use*, which would include all speed regulators.

Regulations for Motor Starting Switches.

The regulations of our fire insurance offices and public supply companies, etc., with regard to motor starting switches are in most cases very stringent. For example, the maximum current which is allowed on the first contact of the switch is generally about five amperes, and some engineers require that a slow motion shall be provided to prevent the current being turned on too rapidly. Most fire insurance companies insist on the resistance being enclosed in an iron case, and another regulation occasionally met with is that the starting lever must be interlocked with the double pole main switch.

Some regulations are practically impossible of fulfilment, but generally speaking the tendency of these regulations has been to bring about a considerable improvement in the design of starting apparatus This is interestingly shown by the fact that English pattern starting switches have found their way on to the Continent, and are being adopted there in preference to the flimsy types which have been hitherto allowed.

Cost of Motor Starters.

The cost of a motor starter of the ordinary type, with metallic resistance, may vary from one-tenth of the price of the motor to as much as half the cost of the machine. On account of expense there is therefore a good deal to be said for the use of liquid resistances, particularly as they are so easily regulated. One point to notice particularly for direct-current motors is that the starter must be provided with a short circuiting switch contact for the "full on" position, otherwise the water will be electrolysed, and the solution require renewing more often. Under certain circumstances the gas might also prove dangerous.

To the writer's mind everything points to the fact that the alternating-current motor is bound to oust the direct-current type in the end, largely on account of this motor starting question. The alternating-current motor, for example, does not require to be taken care of, to anything like the same extent, as it is not necessary to provide the starter with a no load and overload release. Water resistances can also be employed without any electrolysis.

Variation in Speed of Direct Current Motors.

The direct-current motor to be marketable nowadays, must give not only a sparkless commutation, but this must be effected with the brushes on the geometrical neutral point between the pole tips, whether the motor is to be reversed or not. Under such conditions the machine depends for successful commutation mainly upon the carbon brushes, and to the employment of a very strong field relatively to the armature. This latter requirement is especially necessary where the motor is provided with the resistance in the shunt circuit, so that the speed can be varied, for in order to get *increased* speed there has to be a considerable *weakening* of the field.

In a recent article on this subject in the *Electrical Review*, Mr. H. M. Hobart has pointed out that a variable speed machine requires to be designed for good commutation at the highest speed and the highest current. He gives a curve showing that for a motor to commute well at all loads and speeds, and to be at the same time economical in design, there is for each size of motor a maximum speed which must not be exceeded. For 250-volt motors these speeds are :—

2½ h.p.	1,200
5 h.p.	1,000
10 h.p.	800
15 h.p.	700
22 h.p.	600
33 h.p.	500
50 h.p.	400
70 h.p.	350

For 500-volt motors the speeds should be a little lower, and for 125-volt motors they may be a little higher.

Country House Lighting.

With the cheapening of electrical plant and the improvement in small oil engines, there is likely to be a considerable extension in the use of ioslated plants for country house lighting. The writer does not mean large mansions, but the small farms, villas, and hamlets scattered about in country districts, and which have now to use oil. Such places are never likely to have a public supply, and there is generally a gardener or other manservant who can give the little attention required for a small installation. The whole matter seems to rest on the introduction of a cheap, and at the same time a "fool proof" battery, and the nearest approach to this latter desideratum appears to be the one now being made by Mr. Niblett.

One small point in connection with the installation of such an electrical plant is that the engine should be capable of being shut down from a bedroom or landing. By means of a push-button arrangement this could be done by shunting a portion of the current through an electrical magnetic device to turn off the oil cock. In this way the engines could be run up to the last moment, and the accumulator battery would not need to be so large.

Laying Cables on the Solid System.

When laying cables on the solid system the filling in material is usually a mixture of pitch and bitumen having a specific gravity of 1·5 to 2·0. Pure bitumen is, of course, a much better insulator, but it is too expensive to use by itself. On the other hand, pitch by itself is liable to be cracked by traffic passing over it. The kind of filling is not of great consequence, so long as it keeps out moisture and does not attack the lead covering or the cable insulation.

As a matter of fact, the weakest point of the system is at the wooden bridges, and there have been several breakdowns owing to bridges not having the moisture thoroughly driven off before being impregnated. Pot bridges can, of course, be used, but they are expensive. One important matter is that the cable should be prevented from creeping, owing to expansion and contraction. A cable has been known to pull itself straight between two bridges at a sharp corner until it became sufficiently decentralised to touch the inside radius of the iron troughing.

Expansion of Tram Rails.

It is surprising how widespread is the old story of the early railway contractor who butted the rails together with the result that when they expanded the whole lot, sleepers and all, lifted from the ballast and formed an arch. Knowing this story so well, it comes as a shock to the ordinary observer to see tramway rails not only being butted together but actually welded, as at Coventry, by the Falk cast joint, or at Leeds by the Thermit process, or the ends riveted together by a short piece of anchor rail.

It is no doubt difficult for the lay mind to look upon steel as elastic under tension and compression, but this is the explanation along with the fact that tram rails are entirely buried except for the tread, and are therefore only subjected to a difference of temperature of, say, 10° C. Professor Boyes has explained the matter by saying that a rail one mile long and free to move would expand 7 in. with a rise of 10° C., but that if compressed with a force of 3,130 lb. to the square inch it will retain its original length. Now, 3,130 lb. is only about $1\frac{1}{2}$ tons, and is well below the elastic limit of steel, which is ordinarily specified for a breaking stress of twenty-five tons per square inch.

Very few roads, however, are absolutely straight for one mile, so we may consider the case of a curve of 100 ft. radius and rails weighing 100 lb. per yard, the rail section being 10 square inches. A change of 10° C. will change the total longitudinal force by as much as 31,300 lb., and the amount of this per foot run is simply $\frac{1}{100}$ of the longitudinal force of compression or extension if the radius of curvature is 100 ft. $\frac{1}{1000}$ 1,000 ft. radius, and so on. The road bed will therefore be under a side pressure of 313 lb. to the foot run, extending to a depth of 6 in. or 7 in. If the road is so unresisting as to allow the rail to shift laterally to such an extent as to relieve itself entirely of longitudinal stress, a movement of about $\frac{1}{4}$ in. would be sufficient. Of course, in practice, the road would not be unresisting, but even if the rail did move an $\frac{1}{4}$ in. in six months, and came back in the following six months, no harm would be done.

COMING EVENTS—FEBRUARY.

1st.—Society of Arts: Cantor Lecture.—Inst. of Mech. Engineers: Graduates' Meeting at 7.30 p.m.
2nd.—Institution of Civil Engineers: Meeting at 8 p.m.
4th.—Civil and Mechanical Engineers' Society: General Meeting at Caxton Hall, 8 p.m.—Birmingham University Engineering Society, Annual Dinner.
6th.—Birmingham Mechanical Engineers meet.
8th.—Edinburgh University Chemical Society: Ordinary Meeting.—Society of Arts: Cantor Lecture.
9th.—The University of Liverpool Engineering Society: General Meeting in the Lecture Hall at 5.30.—Institution of Civil Engineers: Ordinary Meeting, 8 p.m.
10th.—Mining Institute of Scotland: Meeting at Glasgow.—Liverpool Engineering Society at the Royal Institution.
11th.—Institution of Electrical Engineers: General Meeting.—Birmingham Local Students of the Institution of Civil Engineers: Meeting, Grand Hotel.
13th.—Manchester Association of Engineers: Forty-eighth Annual Dinner.—Birmingham Association of Mechanical Engineers: Annual Dinner.—North of England Institute of Mining and Mechanical Engineers: Meeting at Newcastle-on-Tyne at 2 p.m.
15th.—Society of Arts: Cantor Lecture.—Institution of Civil Engineers: Ordinary Meeting at 8 p.m.
18th.—Institution of Mining and Metallurgy: Meeting at Burlington House at 8 p.m.
19th.—Institution of Mechanical Engineers: Annual General Meeting.—City of London College Science Society: Ordinary Meeting.
20th.—North-East Coast Institution of Engineers and Shipbuilders: Meeting of the Graduate section at Newcastle-upon-Tyne.—Staffordshire Iron and Steel Institute: General Meeting.
22nd.—Society of Arts: Cantor Lecture.—Edinburgh University Chemical Society: Ordinary Meeting.
23rd.—Junior Engineering Society: Meeting at the G.W.R. Mechanics' Institution, Swindon.—University of Liverpool Engineering Society: General Meeting.—Institution of Civil Engineers: Meeting, 8 p.m.
24th.—Liverpool Engineering Society: General Meeting at the Royal Institution, Liverpool.
25th.—Institution of Electrical Engineers: General Meeting.—Leeds Association of Engineers meet.
26th.—North-east Coast Institution of Engineers and Shipbuilders: Ordinary Meeting.
27th.—Manchester Association of Engineers: Meeting.
29th.—Society of Arts: Cantor Lecture.

IRON AND STEEL NOTES.

By E. H. B.

The Development of Swedish Iron Ores.

The year 1903 will be memorable in the annals of Swedish mining for the opening of the Ofoten-Gellivaara line, which has established direct connection between the most northerly bay of the Gulf of Bothnia and the Atlantic. Direct access is thus afforded to the Norrland ores, the far-reaching importance of which has already been referred to in PAGE'S MAGAZINE. Of the principal orefields only, Kirunavaara-Luossavaara and Gellivaara will at present be in touch with the railway, according to *Affärsvärlden*, but the Sjanzeli fields, Nautanen, and Svappavaara will probably be connected with the trunk line in the near future. In *Affärsvärlden* a remarkable description is given of the great orefields of Kirunavaara and Luossavaara. The ore is magnetite, or magnetic iron ore. It forms, probably, two trunk ridges through the length of Kirunavaara and Luossavaara, and especially in Kirunavaara—is massed right up to the highest peaks of the mountain. The highest point of Kirunavaara is 749 metres, and of Luossavaara 729 metres above sea-level, corresponding to 249 and 229 metres, respectively, above the level of the lake of Luossajärvi.

Appearance of the Ore in the Field.

Almost everywhere the ore is well exposed, and on a walk along the mountain ridges the enormous deposits can be well observed. The ridge, covered at the base by birchwoods of small growth, rises as a sharply defined, dark-coloured crest above the brown marshes around. Having passed through the birchwood and over the thin gravel covering up to about one-third of the height of the mountain, one finds it quite bare, and the foot treads on the black ore, the surface of which is broken up in sharp-edged fragments. Impure ore seldom occurs.

The appearance of the ore in the field may, however, often give an erroneous idea of the extent of the deposit. It may look very rich on the surface, and yet be of relatively insignificant dimensions when the depth is examined, and *vice versâ*. This is, however, not the case at Kirunna. Investigations have shown that the ore forms a strongly raised layer, the richness of which diminishes very little in a downward direction. The average thickness in the ore ridge at a certain level has been calculated as 70 metres. The real thickness varies at different levels from 200 metres to 10 metres. The layer everywhere slopes towards the east. The steepest gradient is 67°, and the flattest, 45°.

Estimating the Supply.

These observations are of importance for estimating the ore supply. The official geologist, Mr. Lundbom, now manager of the Ore Company, arrives at the result that this supply amounts to 215 million tons, but this calculation is based on the supposition that the layer tapers downwards. If one might assume that the thickness is uniform right through, the quantity would be 265 tons. These figures are an indication of the colossal supply existing in Kirunavaara alone. Ore of similar quality, and occurring in the same form, is also found at Luossavaara. The ore quantity in this mountain, above the level of the Luossajärvi has been estimated at *eighteen million tons*.

Thus, taking the lower figure for Kirunavaara, we arrive at the respectable total of 233 *million tons* for the two mountains, not including the smaller layers occurring in many places, especially on the slopes of Luossavaara, and the unknown quantity, which probably exists under the lake Luossajärvi.

Methods of Working the Ore.

These layers of ore are unique, not only on account of their dimensions, but also for their quality and the unusual way geologically in which they occur. Unlike iron ore elsewhere, which occurs in slate-like rocks, this is embedded in a typic porphyry.

Interesting particulars are also given of the methods of working the ore. Both at Gellivaara and Kiruna the mining is done in open casts. At Gellivaara, however, owing, to the position of the layers, this work is combined with downcast shafts. The gradient of the layer being rather steep, the open-cast work can only be done to a depth of about 40-50 metres. It is then continued by shafts, which in some places have reached a depth of 200 metres. The ore is sorted in the mines according to the percentage of phosphorus. At Gellivaara there are six qualities, with a percentage of phosphorus from 0·02 to 2.

The sorted ore is sent down by an automatic railway, and put into big containers, from which the trucks are filled. There are two types of trucks, for 35 and 45 tons.

The Present Output.

The mining as well as the handling of the ore is more complicated at Gellivaara than at Kiruna, there being sixteen separate mines in the former place, at varying distances from each other, but the principle of the arrangements is the same in both places.

A large ore production, such as we have not before had in the Scandinavian countries, has been made possible by the systematic planning of the different sections of the work.

At Kirunavaara 3,700 tons ore are now loaded daily, equal to an annual production of one million tons. The production at Gellivaara has during the last few years been 800,000 to 900,000 tons, but it can no doubt

be increased to one million. When the other rich ore deposits in Norrland, which cannot be now worked have been connected with the Ofoten railway, the total ore production will be considerably increased, and there will be an end to the talk about the slumbering millions.

Effect upon the British Iron and Steel Trade.

The possibilities of the North Scandinavian fields are, of course, well known to British ironmasters, a fact which was alluded to by Mr. Bennett H. Brough in the course of a lecture delivered to the members of the West of Scotland Iron and Steel Institute. Reviewing the present sources of iron ore supply, he remarked that while it was true that the richest ores at Bilbao had been exhausted, and that more attention had to be paid to calcination and to the washing of ores of inferior quality to enable them to meet market requirements, there need certainly be no immediate apprehension of a Bilbao ore famine. Far-seeing British ironmasters were, however, already making arrangements for the time when substitutes for the Bilbao iron ores would have to be found. And, happily, there were still large fields of ore, almost untouched, in Scandinavia, in Spain, and in the South of Spain, Algeria, Canada, Cuba, South America, India, and China. The future of the home demand was likely to be affected by the development of the basic open-hearth process of steel making, and there need be no immediate fear regarding the supply of the more impure ores suitable for that purpose. The lecturer remarked that in the year 1902 the world was literally ransacked for fresh iron ore fields to supply rich ores for the British blast furnaces.

A Retrospect.

In the course of a general review of the Iron and Steel and Engineering trades, covering 1903, the *Iron and Coal Trades Review* remarks that, although we can hardly classify 1903 as a satisfactory year, yet, on the whole, it shows an improvement on both 1901 and 1902; in fact, a considerable one on the first of these two, in respect, at any rate, to the volume of trade. Certainly business has not been so bad in most branches of these industries in the Middlesbrough district as it has been the fashion for many to make out during the past few months, whatever may have been the experience in other centres. It is true that there are certain departments which have been very hard hit by depression, and the manufacturers engaged in such branches have very good reason to be "down in the dumps," and to take a pessimistic view of the situation, for with them trade has never been so bad as it has been in 1903. The firms who have suffered so keenly have been those who have had to get their orders mainly from the shipbuilders, whose trade has not been so unfavourable for a good many years, and who are suffering partly from the extensive overbuilding in 1899 and 1900. But makers engaged in most other branches of the iron and steel industries have not had altogether a bad time—makers of foundry pig-iron, ironfounders, steel rail manufacturers, etc., have had a fair time, and we note increases in production and deliveries of iron ore, Cleveland pig-iron, and manufactured iron and steel other than that required in shipbuilding, though at slightly lower prices than were realised in 1902. But, after all, the manufacturers held their own very well during the year, and the fluctuations in values have been of small extent, which fact is exemplified by the small changes that have been reported in the wages of the men, which are regulated by sliding scale; some wages, in fact, have been stationary for considerably over a year.

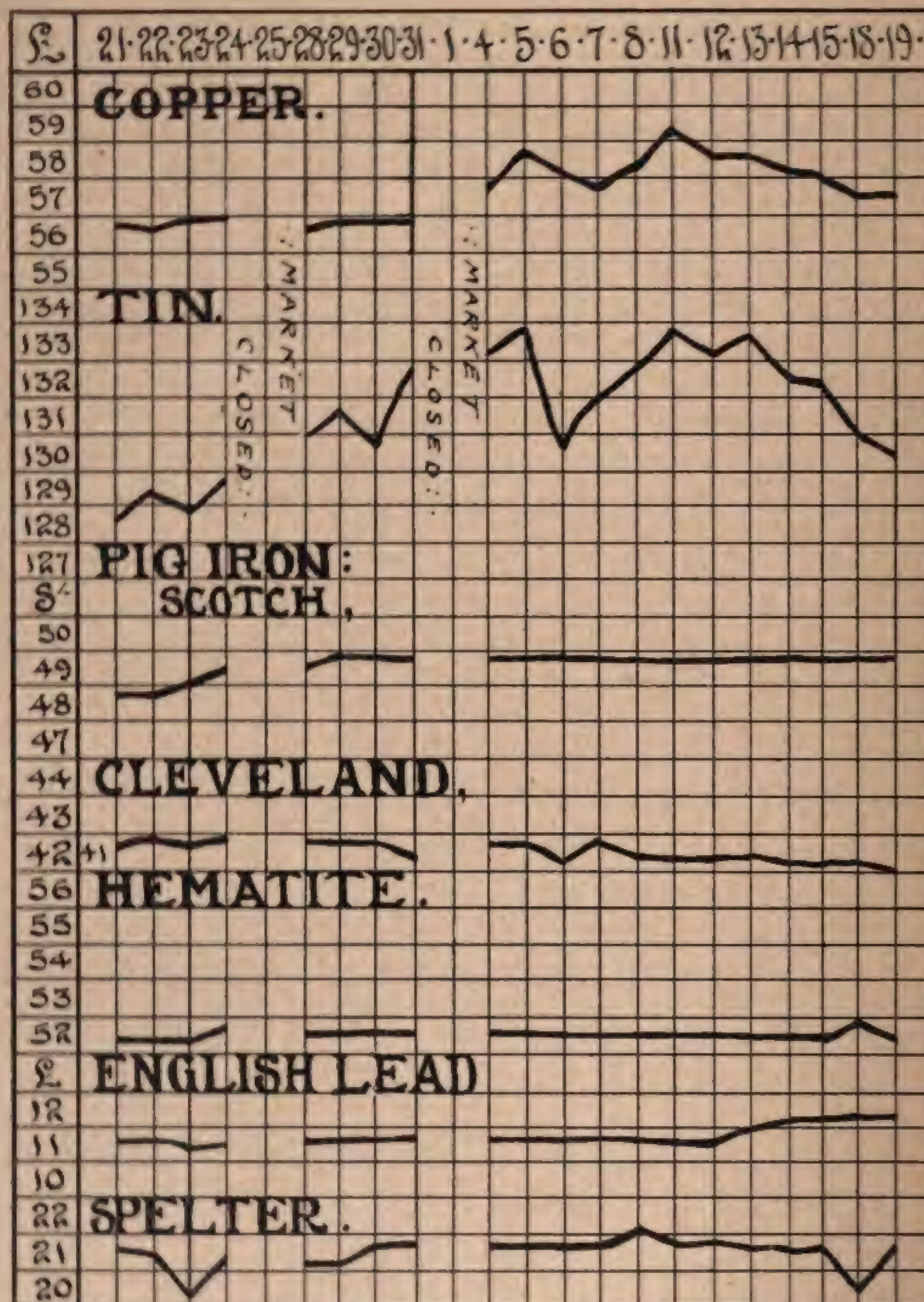
During the year we exported 3,571,373 tons of iron and steel, being 97,728 tons in excess of the exports of 1902, and 758,850 tons in excess of the exports for 1901, though in 1903 lower prices prevailed than in either of the two previous years.

Prospects of the American Iron Trade.

The outlook for the American iron trade in the coming year is not considered a very bright one, since, in addition to a reduced consumption, leaders of industry are confronted with the many perplexing questions which follow in the wake of a boom. What these questions are Mr. C. Kirchhoff concisely sets forth in the American monthly *Review of Reviews*:—

"So far as the probable volume of export sales is concerned," says this authority, "it is not well to indulge in very sanguine expectations. We are not the only ones who are dumping a surplus, nor are our plants so immeasurably better or our costs so much lower that we have foreign markets at our mercy. Our best works are, generally speaking, far ahead in labour-saving appliances, but we need that advantage to offset our higher wages. On the other hand, we are not as economical of fuel nor as careful of waste as the better works of our competitors. Besides, we must descend to the level of the world's neutral markets, which is considerably lower than our own. This must mean some sacrifice, even if due allowance be made for the fact that cost of manufacture is lowered by being able to keep plants at full employment. The moral effect upon home consumers of export sales at lower prices than those prevailing at home is another consideration which must be given some weight. To these very perplexing questions must be added that of lowering cost, to keep pace with shrinking values, with which is intimately coupled the readjustment of the relations with and the remuneration of labour. The price of raw materials, notably fuel, has already given way, and ore may be expected to follow when the time for making new season contracts arrives."

Another authority, the *Iron Trade Review*, is sanguine that with all the disappointments of the closing year the American iron trade enters upon 1904 hopefully, at least; and there is good reason to expect an improvement from the conditions of the past three months. What the railroads do will determine largely the turn of events. With a total of 2,200,000 tons of rails booked for 1903 or carried over from 1902, the rail manufacturers faced 1903 with abundant confidence. To-day they have scarcely more than one-third that tonnage. If the supply of money increases and a market for bonds again appears, so that new work can be financed on favourable terms, the railroads will resume buying iron and steel where they left off some months ago. In other consuming lines there is good evidence that the wait of recent months has been rather for a lower price than for lack of uses for material, and much withheld buying will come out now because it cannot be longer delayed. Indeed, enough business has accumulated in the period of abstention from the market to warrant considerably increased operation of steel works. Moreover, the great consuming West, with its unprecedented bank accounts and its millions of bushels of grain not yet turned into money, has a buying capacity that should be heard from in 1904.



THE HOME METAL MARKET.

Chart showing daily fluctuations between December 21st, 1903, and January 19th, 1904.

AUTOMOBILE NOTES.

The New Act.

The fact that the new Act had come into force was almost immediately noticeable in the metropolitan streets by the advent of the conspicuous numbers, which are now such a feature in automobile traffic. The hostility of certain rural district councils has afforded material for many amusing paragraphs in the Press, and, as might have been expected, some of them do not seem to fully realise the exact limits of their restrictive powers. Happily, however, the zeal of these small anti-motoring councils will be subject to the restraining influences of the county councils. The numbering thus imposed by the new regulations may be unsightly, but it will unquestionably do much to repress the "road hog," and at the same time it is likely to minimise the feeling of antipathy with which motor cars are regarded in some of the rural districts. The speed regulations are another matter. It would rather seem that the duties of the chauffeur will, in course of time, bear some similarity to those of the railway engine driver, and to avoid trouble he will have to know his routes equally well.

Side Slip.

As announced last month, it is proposed by the Automobile Club to hold a novel competition for devices designed for the prevention of sideslip. Every motorist will recognise the utility of such tests, but it seems probable that there will be considerable difficulty in carrying it out, and we shall be somewhat interested in following the arrangements of the organisers. The question is one into which practical experience largely enters, and if any of our readers are able to offer suggestions for the more efficient carrying out of the proposed tests, or can indicate a thoroughly suitable spot for carrying them into effect, we shall be glad to forward such particulars to the promoters.

Endurance Test.

The Automobile Club of America will probably go in for an endurance test during the coming month, when the machines entered will have to encounter snow, ice, and mud, the idea being to test the capacity of the machines as all-the-year-round vehicles. It is said that the manufacturers will welcome the thoroughly effective tests proposed, for they believe that they have very nearly achieved success in making a serviceable vehicle for commercial use at a reasonable price, and are anxious to secure perfection in their machines.

Motor Transport.

A writer in *The South African Mines, Commerce, and Industries*, criticising a recent article in PAGE'S MAGAZINE on Motor Transport, points out that a comparison between mechanical and horse-drawn transport in say, America or England, would not hold in regard to South Africa. There are, of course, factors peculiar to this country which have to be counted on both sides of the calculation, factors which readily suggest themselves and need not be enumerated. The balance of advantage in innumerable cases is believed to be on the side of mechanical transport; but the growth of this form of transport is bound to be more or less slow.

Retrospect and Prospect.

The *Motor* is not able to speak very enthusiastically about the past year. The disastrous Paris-Madrid race, the loss to England of the Gordon-Bennett Cup, and the degradation of the number plate, are all spoken of in regretful strain. Only in one direction was there a gleam of sunshine. This was to be found in the steady growth of motoring among men of moderate means, and the *Motor* is more convinced than ever that in the direction of the light and popular priced car lies the prosperity of the British automobile industry of the future.

Mr. S. E. Garcke, in the course of a review of the Motor Industry, remarks that although many of the best makes of large cars were not exhibited at the November shows—the majority of manufacturers reserving themselves for the shows in February and March—a few were to be seen. Among others, the well-known makes of Beaufort, Talbot (British Automobile Syndicate), Darracq, Sunbeam (John Marston, Ltd.), had good shows. It is mentioned as an illustration of the enormous growth of the motor industry, that A. Darracq and Co. are constructing over 1,000 cars for 1904, ranging from the 8-h.p. single-cylinder to the 30-h.p. four-cylinder.

The *Motor Car Journal* prophesies a busy coming season, not only as regards motor-car competitions, but also in connection with the motor-boat movement. At Cannes, Monaco, and Nice, as well as other pleasure resorts, races are being organised. M. Paul Meyan, of *La France Automobile*, has just offered a cup to the Club Nautique de Nice, which is to be competed for on April 17th next. To become the winner's own property the cup must be won two years in succession. The race, which is to be over a distance of 100 kilometres, is international, each country being, however, only permitted to have in the race one boat, the length of which must not be more than 40 ft. Any number of entries can be sent in from each country, and a series of eliminating races will be held to select the boat to compete in the cup race. Entries are to be sent to the Club Nautique de Nice, 93, Quai du Midi, Nice, before March 30th next.

The future of the Electric Motor Car is discussed in an interesting manner by a correspondent of *Electrical Investments*. For greater freedom and independence the owner of an electric car is bidden to look to Mr. Edison. Says the writer,—we have weighty authority for the statement which is now, we believe, published for the first time, that during the early part of the year 1904, steps will be taken to put the Edison accumulator on the market on a large scale. A factory is to be erected in this country to supply the British demand, which is sure to be very large if the invention is only half as wonderful as it is claimed to be. Our information is that the result of the most severe tests has been such as to astonish eminent experts, who are now convinced that Mr. Edison has solved the problem. The Edison accumulator, we are told, is so much more serviceable than any competitor on the market that it will at once enlarge the range of the electric car to such an extent as to make it a thoroughly reliable long-distance vehicle.

Automobiles in Canada.

According to a Board of Trade report, automobiles have received a good start in Canada. It is expected they will be very common next summer. Practically all of the machines used there at the present time are manufactured in the United States, and a great number of different manufacturers of automobiles are represented. Automobile manufacturing in Canada has not attained any volume at present, but several enterprises are likely to take up the industry.

AMERICAN RÉSUMÉ.

By our New York Correspondent.

NEW YORK, January 19th, 1904.

The World's Greatest Suspension Bridge.

The opening of the Williamsburg Bridge at New York on December 19th, marks the successful completion of a great undertaking. The accompanying plan, for which we are indebted to the *Engineering News*, affords an interesting comparison between the Brooklyn Bridge and the structure which has just been thrown open to the public. An article on the Williamsburg Bridge, by W. B. Northrop, appeared in the October, 1902, issue of PAGE'S MAGAZINE.

Great Engineering Works.

In the course of an article on the engineering outlook for 1904, one of our contemporaries mentions that in the coming year several great engineering works will probably be inaugurated, which will call for all the resources and inventive talent of both civil and mechanical engineers. In this category the writer includes the construction of the Isthmian Canal; the plan of the Pennsylvania Railroad Company to connect its system with the cities of New York and Brooklyn by tunnelling under the Hudson and East Rivers, and the work on the Grand Trunk Pacific Railway, which, by the way, is to be a model for twentieth century railway practice.

The Panama Canal.

The establishment and recognition by this country of the new-born Republic of Panama, says *Marine Engineering*, has settled for all time the question of a trans-isthmian waterway and the part in which this country is to take in it. Our Government will now construct the Panama Canal, and that right speedily, so that within a few years we may expect to see this great waterway open for commerce. It is reasonably anticipated that this will be immediately followed by an immense expansion of trade between our Pacific and Atlantic States, and a new field of commerce will be opened for merchants on the western coast of South America."

It is asserted in some quarters that the unhygienic conditions and intolerable heat of the Isthmian climate will add materially to the bill of cost. It is stated that the Panama Isthmus is not only unfit for colonisation, but life there is a constant battle against unhealthy conditions.

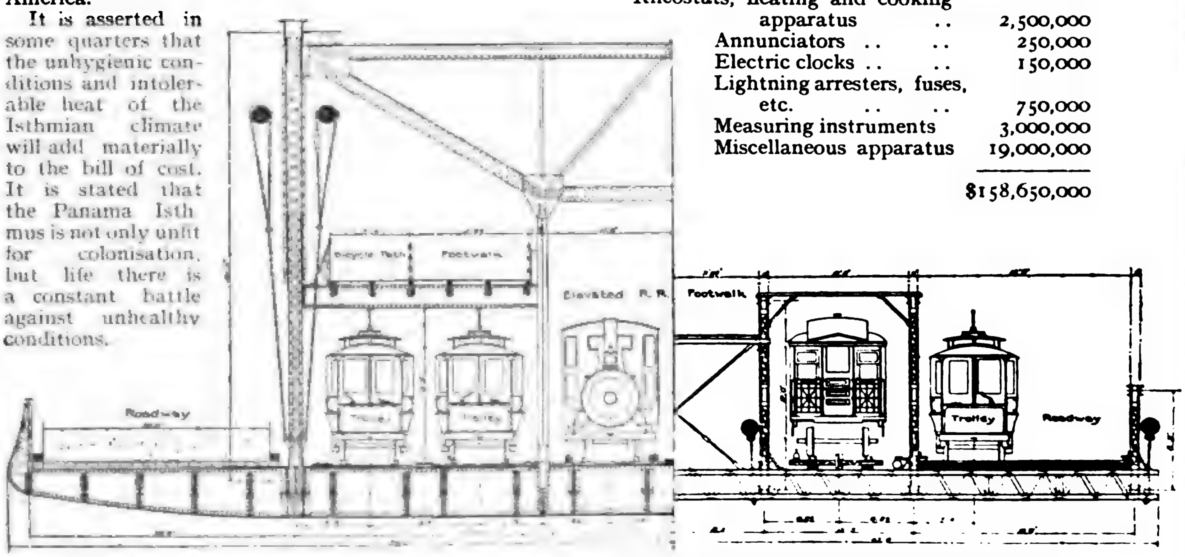
A Novel Application.

Slack time constitutes an evil which is common enough in certain places, but that a city engineer should appeal to have his salary cut down in consequence thereof, is an altogether new phenomenon. At Fargo, No. Dak., Mayor Sweet reported to the council that Acting City Engineer Atkinson felt that the work of his office during the winter months was not of sufficient quantity to demand the whole of his time, and was so unimportant that he did not think he should accept the $100 per month salary, and had asked that it be cut to $50. The council did not look upon the matter very kindly, and Aldermen Schruth, Cummings and McKellar expressed themselves as believing that Mr. Atkinson's services as engineer were well worth what it costs the city. As the salary was fixed by ordinance it was their opinion that it should not be changed.

American Electrical Apparatus.

An estimate of the production of electrical apparatus in this country during the past year works out, according to the *Electrical World and Engineer*, at $158,650,000. the figures are as follows :—

Dynamos	$17,000,000
Transformers	5,000,000
Switchboards, for lighting and power	2,750,000
Motors for all purposes.. ..	30,000,000
Storage batteries	4,500,000
Primary batteries	1,250,000
Carbons	2,000,000
Arc lamps	2,250,000
Incandescent lamps	5,500,000
Lighting fixtures	3,750,000
Telephonic apparatus	25,000,000
Telegraphic apparatus	2,000,000
Insulated wires and cables, submarine cables	30,250,000
Conduits, interior and underground	1,750,000
Rheostats, heating and cooking apparatus ..	2,500,000
Annunciators	250,000
Electric clocks	150,000
Lightning arresters, fuses, etc.	750,000
Measuring instruments	3,000,000
Miscellaneous apparatus	19,000,000
	$158,650,000



HALF-SECTIONS OF THE NEW WILLIAMSBURG BRIDGE AT NEW YORK, AND BROOKLYN BRIDGE.

SOUTH AFRICAN RÉSUMÉ.

BY OUR JOHANNESBURG CORRESPONDENT.

JOHANNESBURG, January 11th, 1904.

De Beers Consolidated Mines.

The annual report of this company contains, as usual, many items of interest to engineers and mining men. For instance, it mentions that the company has just completed, at a cost of £80,000, a central electric station, from which power is to be distributed to the underground machinery as well as to the washing plants, haulage gears, etc. The installation has been supplied by Messrs. C. C. George and Co., of Johannesburg, representing the Westinghouse Company of America. The lighting of the mines, floors, offices, and plants of the company is supplied from the same centre, and it is proposed also to deliver current for lighting purposes to the immediately adjacent townships of Kimberley and Beaconsfield. A suggestion is also made in the report that it may be possible to run an electric tram to Alexandersfontein, the favourite pleasure resort of the Diamond Fields community, where an hotel has been erected by the company at a cost of £25,000. This last fact shows how far-reaching is the interest taken by the company, not only in the work of its employees, but also in the recreation of themselves and their families.

Values and Yields of the Griqualand West Diamond Mines.

The following table, compiled from figures given in the report already mentioned show the quantities and values of the diamonds found per load of blue ground washed during the past year, for the several mines in the district. One load contains 16 cubic feet of material :—

Name of Mine.	Average yield per load in decimals of a carat	Average value per carat.	Average value per load of blue.
		£ s. d.	£ s. d.
De Beers and Kimberley Mines ..	0·61	2 8 6·3	1 9 9·8
Premier Mine, Wesselton ..	0·30	1 14 4	0 10 3·2
Bultfontein Mine..	0·24	1 10 10·2	0 7 5·4

The total output for the twelve months realised £5,241,172.

It is interesting to compare these figures with those of the mines in the Transvaal, where the average production per load has been a little over one carat per load. The average value for a year's yield is £1 7s. 7·4d. per carat, and the total value for the same period only £46,358. The value per load works out at about £1 11s. 3d., or just a little higher than the average of the De Beers and Kimberley mines.

Native Convict Labour on the Rand.

A great deal of the work on the De Beers floors is performed by convict labour supplied by the Cape Government, and as this arrangement has worked satisfactorily for many years it is not surprising that some of the black convict labour available on the Rand should also be used for mining purposes. The Transvaal Government have supplied 1,500 convicts already with the stipulations that they shall be kept in separate compounds, apart from the free labourers, shall be employed for surface work only, and shall receive 1s. 6d. per day. Quarters for the guards have also to be provided by the mining companies.

Native Labour Commission and the Minority Report.

A brief account of the findings of the native Labour Commission was included in the December number of PAGE'S MAGAZINE. It will suffice, therefore, to direct attention to the following summary of requirements :—

	Estimated number required.	Now at work.	Shortage.
Agriculture ..	80,000	27,715	52,285
Mining	197,644	68,280	129,364
Other industries ..	69,684	69,684	No data obtainable.
C.S.A. Railways ..	—	—	—
Open lines	16,000	12,402	3,598
New Construction..	40,000	3,848	36,152
	403,328	181,929	221,399

All these figures, except those for the railways, which include the Orange River Company lines, are for the Transvaal only. No estimate could be arrived at from the available evidence as to the future development and consequent labour requirements of "other industries," and the Commission has not hazarded a guess at the probable shortage under this head. Even at this moment therefore, according to the above tabulated summary, we are confronted with a deficiency of more than half the number of labourers actually and urgently required.

The estimate of the two gentlemen who differed from their ten colleagues was stated as follows :—

Witwatersrand gold mining	91,000
Witwatersrand coal mining	12,000
Other districts gold mining	12,250
Railways	20,000
Agriculture	55,000
Other industries	69,700
	259,950
Subtract number now at work as above..	181,929
Present shortage according to minority report	78,021

Striking an Average.

To allow for any unconscious bias on either side, we may take the mean of the two figures, namely 149,760 as being practically unassailable. Now, on November 30th, 1902, there were 45,445 natives working on mines, and on October 31st, 1903, there were 74,609. The average monthly increase has therefore been 2,514. As the mining requirements are about half the total in each set of figures given above, we may estimate the total increase at 5,000 per month. If this rate of increase could be maintained, it would require two and a half years to obtain our *present* requirements. But this means absolutely no expansion of industrial effort in any direction. Therefore, it is quite evident that, after allowing due weight to the figures of both parties, an importation of labour, as stated in our November notes, is essential to the progress of the Transvaal and the Orange River Colony.

GERMAN RÉSUMÉ.

BY
DR. ALFRED GRADENWITZ.

BERLIN, January 21st, 1904.

Wireless Telegraphy from Running Railway Trains.

Experiments recently made by Professor Biscan, Teplitz, Austria, with a view of using wireless telegraphy apparatus from running railway trains, are said to have, so far, given quite satisfactory results, wireless despatches being safely received and transmitted over distances as high as 7 kilometres from the station erected in Teplitz. The possibility of ensuring wireless communication with running railway trains has thus been evidenced. The car containing the apparatus was coupled to the back of the train, two wires leading outside of it. These wires were conveyed horizontally on both sides of the roof of this car and of three ordinary railway cars, terminating in a horizontal free point; they were intended to replace the antennæ otherwise used in connection with wireless telegraphy stations to enforce the effects of electric waves. As soon as the train approached the Teplitz wireless telegraphy station up to the distance above mentioned whence a continuous supply of despatches was to be given, the telegraph apparatus in the car would begin working, the paper ribbon containing the telegrams running off the roller in a manner quite analogous to an ordinary telegraphic apparatus. Similar experiments have, by the way, been carried out some time ago on the Berlin-Zossen military railway.

Wireless Telegraphy Experiments.

The Berlin Gesellschaft für drahtlose Telegraphie has installed on the Norwegian Loffoden Islands two wireless telegraphic stations at a distance of 50 kilometres, the points chosen being separated by high and continuous rocky masses so as to oppose material obstacles to the passage of the electric waves. These experiments were made with a view of testing the safety of the system under especially unfavourable conditions. The above stations were operated by means of dry cells so as to ascertain whether very small amounts of energy would allow of communication being secured over the distance of 50 kilometres. On account, however, of the obstacles interposed in the direction of telegraphing, the primary energy of a limited number of dry cells was found to be insufficient, an amount of energy as high as about 200 watts being necessary to ensure a regular communication. On the other hand, the above company had some weeks ago made attempts to obtain wireless communication from their large station at Oberschöneweide (near Berlin) as far as Munich and Vienna. On account, however, of the heavy storms prevailing these experiments had to be discontinued, the storm in Berlin tearing off the balloon carrying the antennæ from the rope. In Munich it was equally impossible to send up balloons or kites because of the violent storm. The experiments which were contemplated for some time between the Oberschöneweide station and Karlskrona, Sweden, were commenced on the 16th inst., and, as far as is known, have given satisfactory results.

Strength of Steel Castings at Ordinary and High Temperatures.

The experiments by C. Bach, described in a paper recently published in the *Zeitschrift des Vereins Deutscher Ingenieure* are intended to ascertain the dependency of the mechanical strength of steel castings on temperature; they are relative to castings from three different works, being distinguished by the letters O, K, and M, respectively. It is shown in the first place that the average tensile strengths will augment up to about 300° C.; the author does not note any appreciable influence of the duration of the load. For higher temperatures, on the other hand, the mean tensile strengths are found to increase, viz., for loads lasting about half an hour:—

For casting O from 4,788 (300° C.) down to 2,691 kilogramme-square centimetres (500° C.); K, from 4,242 (300° C.) down to 2,043 kilogramme-square centimetres (500° C.); M, from 4,319 (300° C.) down to 2,274 kilogramme-square centimetres (500° C.)

For more prolonged loads (about 8-12 hours) there is a decrease in the tensile strength, being at 500 C.: for casting K from 2,043 down to 1,561 kilogramme-square centimetres; M, from 2,274 down to 1,911 kilogramme-square centimetres.

As regards, on the other hand, the individual values for the tensile strength, there are in the case of castings O, the lowest departures at ordinary temperature and the highest departures at 300°, whereas, in the case of K and M 100° and 20° respectively will correspond with the minimum departures, and 200° and 100° with the highest departures.

The average fracture tensions are found to decrease in the case of casting O, from 25·5 per cent. (20° C.) down to 7·7 per cent. (200° C.); K, from 29·0 per cent. (20° C.) down to 17·7 per cent. (200° C.); M, from 27·2 per cent. (20° C.) down to 15·2 per cent. (200° C.).

For temperatures upwards of 200°, the average fracture tension will augment again up to 33·3, 51·3, and 26·1 per cent. respectively, at the temperature of 500°.

Prolonged loads will result in the tension being lowered at 300° and 400°, and augmented at the temperature of 500°.

The individual values for the fracture tensions show departures among one another, which augment in some cases at extraordinary rates, for increasing temperatures.

The average contractions of the cross section are found to decrease up to 300°, this decrease being for casting O, from 50·4 (20° C.) down to 15·8 per cent. (300° C.); K, from 56·1 per cent. (20° C.) down to 49·4 per cent. (300° C.); M, from 48·7 per cent. (20° C.) down to 34·7 per cent. (300° C.).

At higher temperatures there is once more an increase, values as high as 44·6, 75·7, and 42·1 respectively being noted at the temperature of 500°. There is moreover, an influence of a prolongation of the load. The departures noted between the individual values are rather high.

From the above it is inferred that a steel casting, while appearing to be a very satisfactory and fairly uniform material with respect to its tenacity at ordinary temperatures, may present little tenacity and uniformity at high temperatures. This behaviour should have an important bearing on the construction of steam boilers, etc., where the strength corresponding to ordinary temperatures is less important than that corresponding to high temperatures.

The Pielock Superheater.

Superheaters have been adopted in connection with locomotives relatively late, in fact long after their use with stationary steam boiler and steam engine plants had been shown to be advantageous. In 1898 the Prussian Railway Administration caused extensive experiments to be made in connection with hot steam locomotives; these experiments resulted in the superiority of the hot steam locomotive, as compared with the wet steam locomotive being demonstrated. Now present superheater types, while fully meeting the requirements of a safe operation, cannot be installed without expensive reconstruction, except in the case of a newly constructed locomotive, necessitating even in the latter case a not immaterial cost (with the Prussian 2/4-high-speed locomotives about 300 to 400).

The Pielock superheater, just brought out by the Hannoversche Maschinenbau A.G. vorm. Georg Egestorff, Linden, near Hanover, is remarkable for its simplicity and suitable arrangement, in addition to its low cost. This superheater is designed not only for locomotives, but for nearly any heating tube boilers, being readily installed in connection with new as well as with existing boilers. In the case of locomotive superheaters, the apparatus is placed in the multitubular boiler, using the existing heating surface of the tubes so as to have the fire gases, necessary to superheat the steam, enter the superheater at a convenient temperature, sufficient to obtain the required steam temperature with a minimum heating surface, while being sufficiently cool to prevent the fire gases exerting any noxious influence on the tube.

The superheater consists mainly of a box, surrounding the existing tube system in the boiler, being readily tightened against the surrounding water as the pressures in the superheater box and in the boiler are identical. This box is divided by partition walls into different compartments, this ensuring a contact as prolonged and as intimate as possible between the steam and the heating tube. The steam enters the superheater box at boiler pressure, traversing the various compartments and entering a box surrounding the governor head. The temperature of the superheated steam is indicated by a thermometer provided with big figures, so as to be easily read from the mechanic's stand. A tube leading from the governor through the dome foot serves to supply superheated steam to the air pump, as well as for cleaning the rails, heating, etc. In the case of any disturbances being noted, the amount of leakage of the superheater may be ascertained.

Experiments so far made on the Pielock superheater have fully borne out the hopes entertained regarding it. In connection with experiments made on behalf of the Russian railway authorities, a saving of coal as high as 15 per cent., and of water as high as 18 per cent., was stated, as compared with similar locomotives fed with wet steam. In virtue of the reduced space of the superheater, any desired temperature up to the maximum of 300° to 350° may be obtained, according to the position and length of the apparatus.

Statistics of German Electricity Works.

The returns published in a recent issue of the *Elektrotechnische Zeitschrift* are intended for ascertaining the present development of electricity works in Germany according to their dimensions and outputs, technical and economical problems being excluded on account of the difficulty met with in getting such information through a private *enquête*, the starting capital being only excepted. As regards the results to be derived from these statistics, we note that in 1903 there existed in Germany fifty electricity works of an output of upwards of 2,000 kilowatts, the two largest being Berlin-Moabit (26,523 kilowatts), and Berlin-Oberspree (25,425 kilowatts). The total output of these fifty largest central stations belonging to thirty-seven cities is 271,479 kilowatts. The increase in the amount of connections in all the works is shown by the following table:—

	Total No. of weeks.	No. of 50 W. glow lamps.	No. of 10 Amp. arc lamps.	No. of motors connected. h.p.
1894	148	493,801	12,357	5,635
1895	180	602,986	15,396	10,254
1897	265	1,025,785	25,024	21,809
1898	375	1,429,601	32,586	35,867
1899	489	1,940,744	41,172	68,629
1900	652	2,623,893	50,070	106,368
1901	768	3,403,205	64,278	141,414
1902	870	4,200,203	84,891	192,059
1903	939	5,050,584	93,415	218,953

Among the 939 works recorded, there is a large number of overland centrals, the current supply of which, so far from being confined to a certain local district, is extended to a considerable number of places. In this connection the Brühl central station of the Berggeist Limited Company should be mentioned, supplying sixty-six localities in a circle 15 to 20 kilometres in radius with current for light and power purposes, as well as the Upper Silesia electricity works supplying the whole of the industrial district of Upper Silesia, and the Rheinfelden power transmission works supplying forty-six localities. Some of the large tramway companies, it is stated, have decided on transforming their tramway central stations into such overland centrals. Moreover, there is in the Rhenanian industrial districts a number of smaller electricity works serving especially for the small and domestic industry. In the Anrath electricity works, near Crefeld, for instance, the motors connected are all of ¼ or ½ h.p., being used in the domestic industry for operating silk ribbon looms.

Whereas in Switzerland, there is a large number of so-called secondary works selling the current supplied from a larger central. The only similar works in Germany, as mentioned in these statistics, is the municipal electricity works of Spandau, near Berlin, where the Berlin-Moabit electric station supplies the current to the town, selling the same to private persons.

MINING NOTES.

The Penetrating Pulley.

A brief account of this appliance was given by Mr. Kenneth H. Brough in the course of one of the Cantor lectures on "The Mining of Non-Metallic Minerals." The wire saw was applied at Carrara for sub-dividing blocks of marble, but the impracticability of using the revolving cylinder, or hand labour for sinking inclined pits, was an obstacle to its further use. The difficulty was, however, overcome by Mr. Monticolo, who invented an ingenious appliance, which he termed a penetrating pulley, with which it is possible to replace the cumbersome but costly pit by a bore-hole 3 in. in diameter. The penetrating pulley consists of a disc 20 in. in diameter, and ¾ in. thick, with a semi-circular groove round its periphery, deep enough to take half the thickness of the wire, the other half projecting. The disc is mounted on a pivot, and is supported by a hollow steel shaft of slightly smaller diameter than the bore-hole. To the shaft is attached a series of tubes of equal diameter, forming a column that may be lengthened at will, in the interior of which is a fine tube, serving for the lubrication of the pivots. As the cut deepens the pulley is fed down automatically by means of an eccentric. For cutting a groove, two bore-holes, to receive the shafts carrying the axes of the pulleys, are first made by hand or by the diamond drill. The pulley was first applied in March, 1898, at the Campanile quarry, Carrara, where cuts have been made 50 ft. long and 16 ft. deep, inclined at an angle of five degrees from the horizontal. The highly satisfactory results obtained with the penetrating pulleys serve to show that there is a great saving of expense by the substitution of bore-holes for pits, far less waste of valuable marble, increased rapidity of quarrying, and consequently increased output.

Slate Quarrying with the Wire Saw.

Mr. Brough incidentally referred to the wire saw method of slate quarrying. He remarked that at Rhiwbach Mr. H. Humphris has introduced an ascending method of working in which all the rock available is procured at low cost. Small cross levels, 4 ft. wide and 8 ft. high, are driven at right angles to the main level. As soon as two of them are 25 to 30 yards long, the rock between is undercut by the wire saw, and top cut at a height of 6 ft. above. The block is sliced off and rough dressed underground. The waste produced is stacked up to the level of the roof, so as to form the floor of the next gallery. At Labassère, in the Pyrenees, the wire saw is employed to make horizontal cuts across the inclined beds of slate, severing great blocks without blasting. Believing that a similar system could be employed with advantage in North Wales, Sir C. Le Neve Foster recommended that Mr. G. J. Williams, Assistant Inspector of Mines, should study the question on the spot. The Home Secretary having acceded to this suggestion, Mr. Williams drew up a very valuable report, which was published in 1900. The investigation clearly showed that slate might be worked in many quarries in North Wales by the wire saw method with great advantage. There would be less blasting, fewer falls of ground, less waste of good rock, reduced cost of working, less use of explosives, a saving in the cost of unproductive work, a saving in the cost of removing rubbish, no need for quarrying worthless rock in underground workings, and the cost of examining and securing the roofs and pillars would be done away with. An article on this subject appeared in PAGE'S MAGAZINE last August.

A New Coalbed.

In the Department of Yoro, in Honduras, a new coal bed has been discovered. Expert examination and test of several samples of the coal taken from or near the surface establish the claim that it cokes with excellent result, but coal taken from a depth of 2 ft. or more exhibited much better qualities, being firm and lustrous. It is, therefore, believed that at a depth of from 50 to 100 ft. the deposits should be found to possess all the requisites of first-class coal. As there are no other coal-fields of value in that part of the continent, it is anticipated that the exploitation of this property will carry with it profitable returns, as well as inaugurate a new industry in a region now but sparsely populated.

Production of Asphaltum and Bituminous Rock in 1902.

The production of asphaltum and bituminous rock in 1902, according to the report of Dr. Joseph Struthers to the United States Geological Survey, showed a large increase over that of 1901, amounting in quantity to 36,525 short tons and in value to dols. 122,259, the figures for the two years being, respectively, 99,659 short tons (677,594 dols.) and 63,134 short tons (555,335 dols.). The relatively smaller increase in value, as compared with quantity, was due to the very large proportion of bituminous sandstone produced.

The production of hard and refined asphaltum increased from 19,316 short tons in 1901 to 22,321 short tons in 1902. The production of liquid asphaltum, all of which was derived from California, decreased from 2,600 short tons in 1901 to 1,605 short tons in 1902. The quantity of asphaltum produced in the refining of crude oil during 1902 amounted to 16,027 short tons.

The imports in 1902 amounted to 153,093 long tons (402,604 dols.) as compared with 138,833 long tons (553,473 dols.) in 1901.

The report contains a brief abstract of the production of asphaltum in Cuba in 1901.

The Chinese Labour Question.

Dr. Jameson, in the course of his speech at Grahamstown, defined his own attitude towards the Chinese labour question. He said that he was opposed to the introduction of Chinese, but, he added, "we cannot dictate outside our own borders." He would, he said, introduce legislation to prevent Chinese from entering Cape Colony. As we go to press we hear that the draft ordinance for the introduction of Chinese labour into South Africa has just been read in the Transvaal Legislative Council. There is still a strong bias against the proposal in some quarters, notwithstanding the numerous safeguards which have been introduced into the scheme. Mr. Seddon has been particularly active in his hostility, and we are face to face with the somewhat unusual spectacle of two Colonial Premiers—Mr. Seddon and Mr. Deakin—going out of their way to protest against a measure affecting a portion of the British Empire, it is true, but in no way connected with their own spheres of influence. I notice that our Johannesburg correspondent makes a further allusion to this question, and as a close observer on the spot his opinions are certainly entitled to some weight. He is emphatically for the introduction of Chinese labour.

OPENING FOR BRITISH TRADE

British India.

The Public Works Department of the Kashmir and Jammu State invite tenders for an electric power installation in the neighbourhood of Srinagar, Kashmir. The maintenance and up-keep of the whole plant for at least one year after completion of the works will have to be included in the tenders. Further particulars can be obtained from the State Engineer, Kashmir Durbar, Srinagar.

Natal.

The Governor of the Colony has been empowered to construct departmentally, or contract for a line of railway commencing by a junction with the existing line at or near the North Shepstone Station, and ending at or near the mouth of the Umhlangeni River, in the county of Alfred; also a line of railway commencing by a junction with the existing line at or near the Ennersdale Station, and ending at or near the "Honger's Poort" Magistracy, on the north side of the Tugela River, in the county of Klip River.

Netherlands.

Tenders for the erection of a telescopic gasometer at Amsterdam having a diameter of fifty metres and a capacity of 60,000 cubic metres, will be opened on the 15th inst.

Spain.

The Government has granted a concession for the construction and working for ninety-nine years, without State subvention, of a narrow-gauge railway, from Puebla de Hijar, by Morella, to the port of Vinaroz, with a branch for the working of the coal measure of Utrillas and another for that of Beceite.

Concessions have been granted, without State subvention, for the following:—

An electric tramway for passengers and merchandise from the city of Orense to the town of Verin, for sixty years. A railway from the high road from Ainzon to Illueca in the district of Tierga, to the station of Morata de Jalón, on the line of railway from Madrid to Zaragoza, for ninety-nine years.

A narrow gauge railway from Alcázar de San Juan, by the towns of Herencia, Villafranca, Camuñas, Madridejos, Consuegra and Turleque, to Mora de Toledo, for ninety-nine years. A narrow-gauge electric railway from Madrid to Arganda, for ninety-nine years.

Portugal.

The Ministry of Public Works, Lisbon, require tenders for the construction of a pier for loading and discharging, with the works corresponding in the port of Lagos at the upset price of 31,000 milries (about £5,200).

Russia.

In view of the development of traffic over the railway system, it has been decided to double the track of each of the following lines:—Warsaw-Malkine, Warsaw-Otvotsk, Sinelnikovo-Alexandrovsk, Kramatorskaïa-Popasnaïa, Korostovska-Zélénaïa, Rostov-Kavkazskaïa, Eaux-Minérales-Prokhladnaïa, and Zamtchalovo-Schakhtnaïa.

A despatch has been received at the Foreign Office, from Warsaw, stating, in connection with the new slaughter-houses and other public works, that there appears to be a good opening for the supply of mechanical parts for the new bridge, and for the supply of ventilators and heating apparatus for the market halls.

Mexico.

A concession has been granted to Messrs. D. J. Arce and F. F. Castello to construct and exploit for the term of ninety-nine years a railway, 914 millimetres gauge, from Tlal'pujahua, in the State of Michoacan, by way of a point near Villa del Oro in the State of Mexico, to Anganguco in the State of Michoacan with such branches as may be necessary, not exceeding 40 kilometres, to open communication with the mineral districts, forests, and villages in the States of Michoacan and Mexico.

New Zealand.

Tenders will be received at the Office of the Christchurch Tramway Board, New Zealand, on or before March 17th, 1904, for the complete installation of electrical tramways other than buildings.

Sections of the above undertaking are divided as follows: — Power-house equipment, steam plant; power-house equipment, electrical plant; steel stack, travelling crane, cooling tower, car-bodies, car-trucks, car motors, compressed air brakes, equipment of cars, and sundry supplies; repair shop tools, rails, fishplates, fishbolts, and special work, permanent way, overhead construction, emergency wagon, destination boxes, tablet, and staff boxes, life guards.

Brazil.

Eugenie de Andrade, the civil engineer, has been granted a decree to construct and work for seventy years an electric railway of 1·35 metres gauge from Rio de Janeiro to Petropolis.

Chile.

A concession has been granted to Messrs. Leopoldo Ottenheim and Carlos Gibbes to construct a narrow-gauge railway between the mineral district of Collahuasi and a point on the Iquique railway situated near the place known as Chalacollo. The same concessionnaires have received permission to construct a carriage road suitable for automobile goods traffic between the places above-named during the construction of the railway.

Tenders, to be opened on June 28th next, are invited for the public electric lighting of the city of Punta Arenas (Straits of Magellen).

WHAT OUR TECHNICAL COLLEGES ARE DOING.

BY

A TECHNICAL STUDENT.

A NEW DEPARTURE—CENTRAL.

THE publication of a journal entitled *The Central*, marks a new phase in the history of the Old Students' Association of the Central Technical College. Judging by the first number, which has an excellent portrait of Professor W. C. Unwin, this will be a very creditable production. The editors are Mr. E. Frankland Armstrong and Mr. Maurice Solomon. It is primarily intended to publish a magazine which will be of interest to the central students, past, present, and future, the second object of the promoters being to produce a magazine which shall be worthy of the college, and which shall serve as a permanent record of the valuable work it is doing. The publication will appear two or three times a year at first, and with greater frequency afterwards if success justifies the undertaking.

OLD CENTRALIANS AND THEIR WORK.

Perhaps the most interesting feature of the magazine is the section which is devoted to the doings of old students. From this we note that no less than four Old Centralians have been appointed to the responsible positions of electrical engineers in charge of H.M. Dockyards. In wishing these gentlemen every success in their new work, it is hoped that they will at some future date furnish an account of their experiences. Mr. R. Wightman goes to the Cape of Good Hope; Mr. A. D. Constable, who held an Institute scholarship in 1892 and the John Samuel scholarship in 1894, to Bermuda; and Mr. J. S. Pringle (Electrical, 1893–6) to Malta. Mr. H. C. Leake, who gained the John Samuel Scholarship in 1892 and the Siemens Memorial Medal in 1894, and who took diplomas in both the engineering and electrical departments, goes to Devonport Dockyard.

In connection with America, says *The Central*, we may refer to the work of Mr. A. S. E. Ackermann, who was both a student and a demonstrator at the college. Mr. Ackermann recently went on a tour through the States investigating American methods of coal cutting by machinery. The results of his observations, after appearance as a series of articles, have been published in book form. He was called upon to give evidence before the Royal Commission on Coal Supplies a short time ago. Mr. Ackermann is acting energetically as secretary to the Civil and Mechanical Engineers' Society, which he has resuscitated into activity after it had been for a long time practically non-existent.

ANNUAL PRIZE DISTRIBUTION AT BRISTOL.

In the course of an excellent address on the occasion of the annual prize distribution at the Merchant Venturers' Technical College, Bristol, Sir William Mather, M.P., remarked that accommodation had been provided all over the country for a considerable amount of thorough technical training; but alas, very little thorough teaching was attempted, because it was not demanded, and little secondary education existed to prepare for it.

It was in vain that we chafed under the stress of competition, while we neglected to possess ourselves of the intellectual weapons which must be added to character, energy, manual dexterity, and large material resources, to hold the field. He would like to see a fiscal programme for education, secondary, technological and university, proposed by a government of this country, to extend over twenty-five years, with the avowed object of giving our people the same advantages of culture as the people of the three great countries, Germany, France and America, enjoy, suitable to the characteristics of our race. We had superior natural gifts and political institutions, the greatest experience, and the greatest command at the lowest price of the world's raw materials for every purpose. We must make a business of education.

PROFESSOR J. WERTHEIMER'S REPORT.

The report of the principal, Professor J. Wertheimer, B.Sc., B.A., showed that since the last annual prize distribution great changes had taken place in the equipment of the college. The laboratory and workshop accommodation had been doubled, and the governors were now in a position to offer opportunities for higher technical education which were at least as good as those obtainable in any city of the same size in the United Kingdom. The laboratories for physics, mechanical engineering and electrical engineering had been doubled in size; a large engine house had been provided, in which there would soon be placed the experimental engine which Messrs. Robey and Co., of Lincoln, were building for them, with its boiler and measuring apparatus of all kinds, as well as two new large dynamos which would be used to supply light and power for the Rosemary Street building and to afford additional opportunities for the electrical engineering students to undertake practical work on a large scale. They now had larger workshops for carpenters, plumbers, masons, bricklayers and boot and shoe makers, as well as new and well-provided shops for printers and bookbinders. All these new rooms had been equipped with the most modern machinery and tools and in accordance with the latest practice.

The college library had been made more accessible to the students by the provision of a reading room at the branch building opposite the college; a new lecture room specially equipped for electrical engineering had been provided in the main building, and two additional lecture rooms for technological classes were available in the new building in Rosemary Street.

In making these improvements, the governors had been aided by a capital grant from the Corporation of the City of Bristol; this had enabled them to complete these changes on a scale worthy of the city.

THE YORKSHIRE COLLEGE.

In order to be fully prepared to meet the responsibilities of a self-contained university, the Council of the Yorkshire College are making an endeavour to increase its capital and income, so as to give additional strength to some of its departments, and to provide sufficient class rooms and laboratories for all its work. By these means it is hoped that the county will possess a university fully equipped to meet all its requirements in matters of higher education.

It is hoped that funds will be obtained by means of private donations, which will provide the university not only with the additional accommodation which the college has long needed, and which is essential for the efficient working of the university, but also with an important accession to the present small endowments which the college possesses.

In the meantime we are glad to hear that the discussions upon the dissolution of the federal Victoria University, which have been so numerous of late, have not injuriously affected the Yorkshire College, but on the contrary have tended to give publicity to its real strength, and the hold it has upon the county in which its work has been done.

It is gratifying to note, owing to the active canvass which has been prosecuted during the year by the Mining Committee, and in particular by Mr. A. Currer Briggs, the chairman, and Mr. W. H. Pickering, H.M. Inspector of Mines, promises of donations to the fund for the building and equipment of the mining department have been received, completing the fund of £7,000, the minimum sum required for that purpose. The Council are thus placed in a position to obtain an addition to the college buildings, which has been much wanted for some years.

The college was attended by 1,191 students last session, as against 1,165 in the session preceding. The increase in the number of registered day students was five, and in the occasional and evening classes twenty-one.

THE UNIVERSITY COLLEGE, SHEFFIELD.

The prospectus of the Technical Department of University College, Sheffield, for the session 1903–4, affords an excellent idea of the important work which is being done under the ægis of Professor Ripper. The Mining Department, under Professor F. W. Hardwick, M.A., has for some years past met the needs of nearly 1,000 students, the actual number entered for instruction in 1902–3 being 966. With regard to the local classes in the West Riding, these are instructed on a syllabus drawn up some years ago by the college authorities and the Education Committee of the County Council. Last session this syllabus was introduced optionally into Derbyshire, and is now being taken by nearly half the classes in that county; previously the local mining classes in both counties were instructed on the syllabus issued by the Board of Education in subject XVIII. "Principles of Mining."

IMPORTANT DEVELOPMENTS AT BRADFORD.

During the past year the Technical Instruction Committee of Bradford have been seriously considering the question of extending their college, and some important developments may be expected shortly. Towards the close of last session a number of firms, comprising the Bradford branch of the Engineering Employers' Federation, approached the Committee with a view of obtaining special facilities for the training of their apprentices. In consultation with the head of the department, a scheme was prepared, and was approved by the Committee, whereby the employers agree to send their apprentices to the college on one afternoon per week, without loss of wages, the fees being paid by the employers. The apprentices, on their part, undertake to attend classes on two evenings weekly, for which, if a satisfactory report be obtained, the fees will also be refunded by the employers. It is estimated that about seventy apprentices from the various works in the city will attend the college in accordance with this scheme, which will come into force next session.

A sidelight on the practical use of the college is afforded by a note in the annual report of the Committee, which gives the names of forty-four students who, at the close of the last session, had passed through the department and obtained situations on leaving.

At the annual prize distribution on December 9th, the chairman, Alderman W. E. B. Priestley, was able to report that the number of students was now 1,395, an increase of nearly six hundred during the past four years.

HINTS FROM SIR THOMAS WARDLE.

In the course of an instructive address, Sir Thomas Wardle, President of the Silk Association of Great Britain and Ireland, said it was now conceded that if technical education was to be as effective and thorough as it was in America and Germany, there must be something more than primary education to precede it. He emphasised the necessity of a thoroughly good secondary education up to sixteen years of age, and commented upon the rapid extension of the college, and the crying need of money which existed for further extension and equipment, more especially in their engineering, chemistry, and dyeing departments. Industries could not now be carried on successfully by rule of thumb, as they formerly were. It was only by scientific methods of working, and utilising the most recent developments, that satisfactory progress could be made, or a remunerative business conducted. He considered that inducements ought to be provided by the State for boys of all conditions in life to continue at school long enough to be fit for technical instruction. He would like to see the immediate appointment of a Minister of Commerce of Cabinet rank, who would do great industrial service by assisting our Chambers of Commerce in examining the Patent Laws. In conclusion, he advised students not to be tempted to make short cuts at efficiency, whether by irregular attendance or by short and abnormal sessions. Sound training can only be achieved by regularity of study and work in the day classes, and by going fully through the whole course of the curriculum provided for each vocation. It is not enough to trust to evening classes if the highest competency is to be attained.

METALLURGY RESEARCH SCHOLARSHIP.

We are advised by the authorities of King's College London, W.C., that the Institution of Mining and Metallurgy Research Scholarship of £50 has been awarded by King's College, London, to Mr. R. S. Bradley. We hope to say something about Mr. Bradley's work next month.

NOTABLE BRITISH PAPERS.

A Monthly Review of the leading Papers read before the various Engineering and Technical Institutions of Great Britain.

MARINE PETROL ENGINES AND MOTOR LAUNCHES.

IN the course of a paper on the above subject, read by Mr. O. Sumner before the Institute of Marine Engineers, the two types of marine petrol engine known as the two-cycle and the four-cycle, were contrasted. The author explained that the former had an impulse per revolution, and the latter an impulse every second revolution. Simple, reliable, and effective though the two-cycle engine might be for any practical use, it had theoretical imperfections not found in the four-cycle type. It had not a complete exhaust or scavenging stroke, and a certain residue of the burnt gases from the previous impulse must be left in the cylinder, when the top edge of the piston had closed the exhaust port. The two-cycle engine, simple as it looked, was a far more difficult engine to design than the four-cycle, owing to the fact that its two strokes must provide for the various functions for which in the four-cycle engine four strokes were provided. It was not correct, as stated by some manufacturers, that the two-cycle engine would develop twice the horse-power of a four-cycle engine of similar dimensions. It was only with a four-cycle engine that they could possibly obtain the fullest kinetic value out of the fuel, but it would strike marine engineers that the heavy blow at the moment of impulse, which must impart such energy to the comparatively very heavy flywheel as would carry it for three more strokes with no perceptible reduction in speed, entailed heavy wear and tear, and the fact that that was allowed for by giving all parts subject to the shock additional length and diameter, while mitigating, did not remove the objection. The four-cycle engine was unquestionably the engine for large craft, whilst the two-cycle engine was suitable for any class of launch up to about 50 ft.

THE HEAT TREATMENT OF STEEL.

SIXTH REPORT TO THE ALLOYS RESEARCH COMMITTEE.

AT a meeting of the Institution of Mechanical Engineers, held on the 15th ult., the sixth report of the Alloys Research Committee on the Heat Treatment of Steel was presented. It is a work of eighty-four pages packed with exceedingly valuable information, and has numerous plates, including altogether no less than 162 figures, and many photo-micrographs.

The first ten pages are by the late Sir William C. Roberts-Austen, K.C.B., D.C.L., the remainder having been added by Professor William Gowland. We hope on a future occasion to deal more in detail with this report, but in the present issue are unable to find space for more than a few of the most important tables.

Eight series of bars were supplied for these experiments. The compositions of these bars were as follows:—

ANALYSES OF THE BARS BY MR. F. W. HARBORD, ROYAL INDIAN ENGINEERING COLLEGE.

	A	B	C	D	E	F	G	H
Carbon ...	0·130	0·180	0·254	0·468	0·722	0·871	0·947	1·306
Silicon ..	0·020	0·024	0·033	0·072	0·098	0·080	0·081	0·050
Sulphur ...	0·020	0·020	0·020	0·025	0·020	0·019	0·019	0·017
Phosphorus	0·011	0·022	0·025	0·016	0·015	0·019	0·013	0·015
Manganese	0·185	0·250	0·190	0·160	0·217	0·190	0·181	0·180
Arsenic ..	0·024	0·007	0·007	0·007	0·007	0·010	0·003	0·003

Tests were made on the different sets of bars as received, and after they had been subjected, respectively, to the following treatment: Annealed for half an hour at the following temperatures:—620° C. (1,148° F.), 720° C. (1,328° F.), 800° C. (1,472° F.), 900° C. (1,652° F.), 1,100° C. (2,012° F.) Soaked for twelve hours at approximately the temperatures given above.

Quenched at the following temperatures in water:—720° C. (1,328 F.), 800° C. (1,472° F.), 900° C. (1,652° F.), 1,200° C. (2,192° F.). Quenched in oil.

Rolled steel, which was the material chosen for the experiments, has, of course, relatively higher importance on account of its wide use for constructional purposes. Each test piece, after receiving its thermal treatment, had a portion of one of its ends removed for examination under the miscroscope. The bars were then mechanically tested for:—(1) Breaking stress; (2) elastic limit; (3) elongation; and (4) reduction of area. Some particulars of these tests will be found on the opposite page.

THE ELECTRICAL RECONSTRUCTION OF THE SOUTH LONDON TRAMWAYS ON THE CONDUIT SYSTEM.

AT a recent meeting of the Institution of Civil Engineers, a paper was contributed by Mr. Alexander Millar, A.M.Inst.C.E., on "The Electrical Reconstruction of the South London Tramways on the Conduit System." The route length of the Tooting lines is slightly over eight miles.

Drainage of the conduit is provided for by connecting it to the sewers at intervals of sixty yards. These connections pass through a settling chamber, which intercepts the mud from passing into the sewers. The slot-rails are supported by the yokes and the track rails by an 8 in. concrete bed, and both are held to gauge by tie bars fixed to projecting lugs on the

Comparison of Breaking Stresses (in tons per square inch) of Annealed and Soaked Bars

Carbon per cent.	Original bars as received.	Bars annealed for half-an-hour					Bars soaked for twelve hours			
		620° C. (1148° F.)	720° C. (1328° F.)	800° C. (1472° F.)	900° C. (1652° F.)	1100° C. (2012° F.)	620° C. (1148° F.)	720° C. (1328° F.)	900° C. (1652° F.)	1200° C. (2192° F.)
0·130	30·22	—	29·16	29·10	31·48	—	19·73	30·60	—	—
0·180	31·32	30·60	26·32	28·46	27·84	26·91	26·81	27·73	29·94	25·27
0·254	33·33	24·30	25·80	29·40	29·46	28·11	28·60	29·18	29·56	24·96
0·498	36·86	37·02	32·82	30·06	32·44	35·30	38·01	29·31	30·91	29·10
0·722	49·00	39·32	39·96	42·48	43·30	42·38	40·08	38·11	43·21	40·17
0·871	50·02	56·02	44·96	52·30	50·40	47·00	46·25	39·85	40·38	39·56
0·947	50·74	52·90	30·30	30·98	51·12	49·08	48·41	38·73	47·76	34·02
1·306	56·11	51·34	50·88	59·12	44·82	46·02	46·96	38·38	44·41	38·93

Comparison of Breaking Stresses (in tons per square inch) of Bars Quenched in Water and in Oil.

Carbon per cent.	Original bars as received.	Quenched in Water at 20° C. (68° F.)				Quenched in Oil at 80° C. (176° F.)					
						Not tempered.	Tempered at 350° C. (662° F.)			Tempered at 600° C. (1112° F.)	
		720° C. (1328° F.)	800° C. (1472° F.)	900° C. (1652° F.)	1200° C. (2192° F.)	720° C. (1328° F.)	720° C. (1328° F.)	870° C. (1598° F.)	1000° C. (1832° F.)	800° C. (1472° F.)	900° C. (1652° F.)
0·130	30·22	34·18	30·96	38·84	44·20	36·68	30·13	34·60	36·91	31·42	34·55
0·180	31·32	44·88	40·02	49·92	73·73	36·79	31·10	36·12	35·06	34·16	30·13
0·254	33·35	43·20	62·38	70·32	77·04	37·84	34·15	41·18	50·38	—	31·24
0·498	36·86	39·60	61·36	65·44	81·74	39·73	41·63	54·65	54·10	41·06	38·71
0·722	49·00	51·00	*	61·96	13·44	50·48	46·70	78·30	76·41	38·47	39·44
0·871	50·02	54·54	*	58·04	5·40	76·77	38·94	90·08	88·84	33·11	42·68
0·947	53·74	56·04	*	21·80	4·20	38·30	54·68	102·32	94·19	45·97	40·10
1·306	56·11	55·94	70·02	*	3·32	56·82	37·75	90·57	90·00	46·84	51·32

* Broke in clips.

Comparison of Elastic Limits (in tons per square inch) of Annealed and Soaked Bars.

Carbon per cent.	Bars annealed for half-an-hour					Bars soaked for twelve hours			
	620° C. (1148° F.)	720° C. (1328° F.)	800° C. (1472° F.)	900° C. (1652° F.)	1100° C. (2012° F.)	620° C. (1148° F.)	720° C. (1328° F.)	900° C. (1652° F.)	1200° C. (2192° F.)
0·130	—	11·34	10·20	13·02	—	10·44	11·07	—	—
0·180	20·50	14·32	16·08	15·84	15·37	14·31	7·65	20·62	20·76
0·254	27·70	10·24	19·44	17·28	14·30	17·22	15·61	15·60	17·00
0·498	27·36	21·00	19·72	16·06	14·30	22·08	11·76	20·50	23·70
0·722	34·02	22·96	†	†	†	21·13	10·10	20·74	20·01
0·871	30·30	†	†	†	†	21·06	15·30	40·76	21·05
0·947	31·30	†	22·30	†	†	25·15	14·11	30·07	30·00
1·306	40·92	†	†	†	†	20·30	11·60	30·04	36·77

† No definite yield point.

Comparison of Elastic Limits (in tons per square inch) of Bars Quenched in Water and in Oil.

Carbon per cent.	"Normalised" Bars. Annealed at 620° C. (1148° F.)	Quenched in Water at 20° C. (68° F.)				Quenched in Oil at 80° C. (176° F.)					
						Not tempered.	Tempered at 350° C. (662° F.)			Tempered at 600° C. (1112° F.)	
		720° C. (1328° F.)	800° C. (1472° F.)	900° C. (1652° F.)	1200° C. (2192° F.)	720° C. (1328° F.)	720° C. (1328° F.)	870° C. (1598° F.)	1000° C. (1832° F.)	800° C. (1472° F.)	900° C. (1652° F.)
0·130	—	†	†	24·30	†	18·07	11·00	18·00	19·08	19·78	18·08
0·180	20·50	†	†	†	†	24·36	16·88	20·81	23·62	19·02	24·38
0·254	27·78	†	†	†	†	24·94	23·06	20·81	26·20	—	26·00
0·448	27·36	†	†	†	†	20·14	25·68	46·32	27·34	31·92	29·02
0·722	31·08	†	†	†	†	30·74	27·47	36·84	30·96	40·90	44·08
0·871	40·38	†	†	†		80·94	27·86	47·83	30·30	40·04	40·05
0·947	34·30	†	†	†	†	40·00	34·38	46·73	40·13	36·70	40·18
1·306	40·92	†	†	*	†	37·75	40·18	34·80	60·82	42·30	48·60

* Broke in clips. † No definite yield point.

Comparison of the Elongations per cent. on 2 inches of Annealed and Soaked Bars.

Carbon per cent.	Original bars as received	Bars annealed for half-an-hour.					Bars soaked for twelve hours.			
		620° C. (1148° F.)	720° C. (1328° F.)	800° C. (1472° F.)	900° C. (1652° F.)	1100° C. (2012° F.)	620° C. (1148° F.)	720° C. (1328° F.)	900° C. (1652° F.)	1200° C. (2192° F.)
0·130	30·00	—	44·30	46·20	43·00	—	46·30	42·80	—	—
0·180	12·80	38·00	36·00	35·00	38·50	30·50	32·50	29·50	37·00	18·00
0·254	12·70	24·00	32·50	29·50	32·50	33·50	31·00	31·00	29·00	12·80
0·448	6·25	24·00	30·00	27·50	28·00	27·00	33·00	30·50	30·00	10·00
0·722	11·72	20·30	23·00	17·70	16·50	14·00	20·30	21·00	12·30	11·00
0·871	5·47	12·00	20·00	11·50	11·80	11·00	19·80	10·50	11·00	20·00
0·947	7·88	15·00	22·00	18·00	10·00	7·80	10·50	23·50	11·00	20·00
1·306	7·00	*3·00	7·00	20·00	8·30	6·30	11·30	20·00	10·00	23·00

* Broke outside gauge points.

Comparison of the Elongations (per cent. on 2 inches) of Bars Quenched in Water and in Oil.

Carbon per cent.	Original bars as received	Quenched in Water at 20° C. (68° F.)				Quenched in Oil at 80° C. (176° F.)					
						Not tempered.	Tempered at 350° C. (662° F.)			Tempered at 600° C. (1112° F.)	
		720° C. (1328° F.)	800° C. (1472° F.)	900° C. (1652° F.)	1200° C. (2192° F.)	720° C. (1328° F.)	720° C. (1328° F.)	870° C. (1598° F.)	1000° C. (1832° F.)	800° C. (1472° F.)	900° C. (1652° F.)
0·130	30·00	22·00	21·70	20·00	9·00	26·00	41·00	30·30	32·35	36·00	40·70
0·180	12·50	14·00	14·50	6·30	3·80	25·00	20·00	23·80	28·80	26·08	20·00
0·254	12·70	13·70	6·50	3·80	3·00	22·00	25·40	24·80	19·00	—	26·20
0·448	6·25	21·00	1·08	1·00	Nil	24·50	20·00	25·00	14·00	17·00	27·20
0·722	11·72	17·80	*	1·00	Nil	16·50	21·80	23·50	14·00	17·80	17·50
0·871	5·47	15·80	*	2·00	Nil	13·00	13·30	10·50	9·80	15·00	15·80
0·947	7·08	19·00	*	Nil	Nil	12·00	12·00	7·00	3·50	12·00	17·00
1·306	7·08	8·00	0·80	—	Nil	7·00	6·30	3·50	3·00	7·30	17·00

* Broke in clips.

Comparison of the Reductions of Area at Fracture (in Percentages) of Annealed and Soaked Bars.

Carbon per cent.	Original bars as received.	Bars annealed for half-an-hour.					Bars soaked for twelve hours			
		620° C. (1148° F.)	720° C. (1328° F.)	800° C. (1472° F.)	900° C. (1652° F.)	1100° C. (2012° F.)	620° C. (1148° F.)	720° C. (1328° F.)	900° C. (1652° F.)	1200° C. (2192° F.)
0·130	34·73	—	73·28	71·16	71·16	—	81·12	73·21	—	—
0·180	29·71	62·86	72·54	67·52	60·24	60·60	71·48	61·11	58·80	49·50
0·254	25·31	58·06	62·68	58·84	54·84	54·77	68·18	57·28	57·50	56·80
0·448	16·76	49·70	56·58	45·60	46·26	40·58	67·61	42·70	48·50	38·60
0·722	3·43	23·68	47·88	31·74	25·66	17·21	46·64	35·97	14·00	11·80
0·871	5·38	22·11	40·42	16·92	13·84	12·31	30·92	29·60	15·90	40·90
0·947	6·63	27·00	45·00	28·44	15·42	9·07	27·10	38·44	11·00	37·50
1·306	8·48	5·90	6·12	82·90	5·58	8·94	16·43	34·80	11·70	21·70

Comparison of the Reductions of Area at Fracture (in Percentages) of Bars Quenched in Water and in Oils.

Carbon per cent.	Original bars as received.	Quenched in Water at 20° C (68° F)				Quenched in Oil at 80° C. (176° F.)					
						Not tempered.	Tempered at 350° C (662° F)			Tempered at 600° C. (1112° F)	
		720° C. (1328° F.)	800° C. (1472° F.)	900° C. (1652° F.)	1200° C. (2192° F.)	720° C (1328° F.)	720° C (1328° F)	870° C. (1598° F.)	1000° C. (1832° F)	800° C. (1472° F.)	900° C (1652° F.)
0·130	34·73	80·20	30·94	76·36	30·18	50·08	75·91	76·44	67·48	70·60	72·00
0·180	29·71	46·92	51·60	36·36	5·16	60·94	39·48	65·28	63·04	57·00	54·50
0·254	25·31	45·96	8·04	18·44	4·74	67·77	57·87	62·14	60·51	—	58·40
0·448	18·76	48·70	6·00	2·04	Nil.	46·82	50·12	47·77	63·50	56·30	51·00
0·722	3·43	32·92	*	2·08	Nil.	36·84	34·00	36·06	32·60	30·90	33·30
0·871	5·38	29·58	*	2·16	Nil.	36·84	27·63	31·92	24·15	32·60	30·00
0·947	5·63	24·70	†	Nil	Nil	19·61	18·64	16·30	14·64	12·90	26·00
1·306	8·48	15·84	1·32	†	Nil.	9·67	—	10·57	7·00	22·00	21·06

* Broke in clips. † Broke outside gauge points

TABULATIONS FROM THE SIXTH REPORT OF THE ALLOY'S RESEARCH COMMITTEE.

yoke head. At junctions and crossings steel castings take the place of the rolled rails, and specially-wide yokes are used to embrace the converging conduits, and to support the track rails as well as the slot rails. The mechanism for operating the slot and track points at junctions is contained in a concrete pit built immediately underneath the track. Both track points are fitted with 8 foot movable tongues, which are connected together to the slot leaves by a series of cranks and adjustable links, so that the whole can be moved in unison by inserting and manipulating a lever either in a box in the footpath, or alongside the track. The free end of the slot leaves is bevelled off, so that a car trailing through can push over the points without any external assistance. A feature about the work is that at no part is the slot wider than ¾ in.

GRINDING MACHINERY AND ABRASIVE WHEELS.

THIS was the subject of a paper read by Mr. Keith C. Bales, at a meeting of the Institution of Marine Engineers. The paper dealt in detail with the various forms of grinding tools, and gave examples of the work they are capable of doing.

Although the grinding machine has been in use for a number of years, it was, he said, of comparatively modern introduction, especially in machine shops on general work, but it was becoming an indispensable tool in up-to-date works. It had been proved beyond dispute that the lathe was incapable of producing accurate work, even in soft metal, and altogether failed when called to operate upon hard metals. With the grinding machine, however, the same degree of accuracy could be obtained whether the metal being ground was soft, such as copper and its alloys, or hardened steel and chilled rolls. The economy of grinding for finishing work was proved by the fact that emery or other abrasive wheels, to grind a given amount of work, cost less than files, oil, and emery cloth, and reduced the time of production, besides giving accuracy, which, being incidental to the process, cost nothing. The most important part of the grinding machine was, of course, the grinding wheels, and those had two distinguishing characteristics, either or both of which might be varied according to the class of work to be done. Emery used in the manufacture of the wheels was found in the form of rock and was crushed into various grades of fineness. Another substance of which abrasive wheels were partly made was corundum, a mineral similar to emery. Corundum was becoming scarce, and carborundum, a manufactured substance, was now largely used. The component parts of carborundum were coke, sand, and salt, fused by the electric arc.

Mr. James Howie, who opened the discussion on the subject, said he had rather a fear as to the abrasive wheels bursting, and he thought the speed mentioned was a terrific speed at which to drive them. He would like to know if Mr. Bales had had any experience of wheels bursting. Manufacturers were rather diffident about installing those machines for heavy work, but they were all right for finer work.

Mr. F. Cooper said it was a matter of controversy whether it were better to move the work or the wheel. Some emery wheels now made were fitted with wire, and it was claimed for them that they were perfectly safe and almost unburstable. He believed the best makers tested all their wheels at a certain speed in wooden cases, so that the man who performed the test could not be injured if the wheel burst. That man had to go before a Justice of the Peace and swear that he had tested that particular wheel at a certain speed. The wheels were, as a rule, tested to about twice their running speed.

Mr. S. C. Sage said he had been over a factory in Holland where they made marine engines for war vessels, and they told him that all their piston-rods for all kinds of engines were ground up after passing through the lathe. He saw the operation being carried through. Every piston-rod and the valve spindles were ground up, and they were also grinding the reversing links. Holes were lapped, and every cast-hardened surface was ground up after being hardened. The grinding machines came originally from America, but on the Continent, especially in France and Germany, they had adopted them more than we had hitherto.

Mr. Bales then furnished some lengthy particulars as to the comparative times of production in finishing lathe mandrils or spindles in the lathe and by the use of the grinding machine, from which it appeared that, besides the saving obtained in finishing by grinding, much more accurate work was produced. They had heard it stated that grinding machines were in use in Holland and America, and he wanted to know why they should not have them in this country.

THE INSTITUTION OF CIVIL ENGINEERS.

AT the ordinary meeting on Tuesday, the 22nd December, 1903, Sir William H. White, K.C.B., President, in the chair, the Paper read was "On the Resistance of Plane Surfaces in a Uniform Current of Air," by T. E. Stanton, D.Sc., Assoc.M.Inst.C.E.

The paper deals with the results of experiments made in the Engineering Department of the National Physical Laboratory on the distribution and intensity of the pressure on thin plates and combinations of plates placed in a uniform current of air, and is intended as the first part of a research on the nature and distribution of the pressure of the wind on structures. By a uniform current of air is meant a current in what is known as "eddying motion" as distinguished from stream-line motion, the mean velocity at any point in the direction of flow being uniform across the current. This condition of motion is considered to be the nearest approximation to that of winds of fairly high intensity. The main object of the present research was to determine, if possible, a general relation between the velocity of the current, the dimensions of the plates, and the resultant pressure, as it was felt that experiments in the open air could not be undertaken with any prospect of success until some general relation of the kind had been established. The results of the experiments show that, under the given experimental conditions, a definite relation of the kind existed and may be stated thus: For similar and similarly situated plates or combinations of plates in a uniform current of air, the intensity of pressure is the same for the same velocity of current and general atmospheric conditions. On the assumption that the motion of the wind approximates to that of a uniform current as defined above, the above relation shows that the distribution and intensity of the pressure of the wind on structures may be studied experimentally by means of models of the structures set up in a current of air produced by means of a fan, as in the present case. In illustration of this, the results of experiments made on models of roofs and lattice girders of simple form are given in the paper.

Tabulated results are also given for the cases of parallel plates at varying distances apart, plates inclined at varying angles to the direction of the current, and rectangular plates of varying ratio of length to width.

THE KOLAR GOLD FIELD.

IN a paper contributed to the Institution of Mining and Metallurgy, Mr. A. Mervyn Smith brought the geology of the Kolar Goldfield up to date.

A RICH YIELD.

The Kolar Goldfield, though one of the smallest in the world in point of area, is one of the richest—if not the richest—in point of gold production. Up to September last it had yielded no less than sixteen millions sterling in gold, of which six millions has been paid away in dividends to shareholders, while the annual output has now reached the large total of two and a quarter millions sterling. The industry at the same time gives employment to some twenty thousand mining men, hundreds of whom are miners from this country, and some of them members of this institution. The question how long this flourishing state of things may be expected to continue is one of great importance.

SOME CHARACTERISTICS.

On the geological map, published by the Government of India (December, 1892), fifty thousand square miles of surface are marked as covered by gold-bearing rocks, known as the Dharwar series of India. Three great areas of these rocks are shown, occurring at wide intervals from each other. One of these is in South India, another in Bengal, and a third in Central India. All of them show signs of extensive denudation in the numerous outlying little patches of auriferous rock, which were at one time part of the big areas.

The Kolar Goldfield is one of a number of such small patches fringing the southern border of the Dharwar rocks of South India. It is some forty miles long from north to south, and from three-quarters of a mile to four miles wide from east to west.

The Kolar goldfield may be briefly described as a narrow band of schistose rocks surrounded by granite. Quartz reefs occur in the granite as well as in the schistose rocks, but only those in the schistose band have been proved to be auriferous. This schistose band stretches north and south a distance of forty miles, and has a varying width of from one to four miles. The "strike" of the foliation of these schistose rocks (known in Indian geology as the "Dharwars") is generally north and south, though, owing probably to lateral pressure, due to intrusions of the newer granites, the line is somewhat sinuous.

The reefs on the Kolar field fold back on themselves in many places. This is particularly noticeable in the case of the Champion lode on the Mysore, Champion Reefs, and Nundydroog properties. Where these folds come to the surface, three parallel lodes are seen near to each other, and extending sometimes a length of 200 ft. along the strike of the country, north and south. These folds have a pitch north at an angle of about 45°.

Another feature that plays an important part in all questions of development is the occurrence of numerous large dykes of acid and basic rocks. Many hundreds of dolerite dykes may be seen cutting across the schist belt from east to west, and a few from north to south. Those running north and south are larger and more marked than the others. It is thought that these basic dykes are younger than any of the other rocks seen on the Kolar goldfield, as they traverse indiscriminately the surrounding granito-gneiss as well as the schists.

GENERAL CONCLUSIONS.

Veins of pegmatite also cut across the schists from the east to west, and dislocate the quartz lodes. Mr. Bosworth Smith believes they also cut through the dolerite dykes. If this is the case, then they must be younger than the basic dykes.

To summarise, then, it may be said that all observers who have written on the geology of this field are agreed :—

(1) That the auriferous rocks form a narrow band, from one to four miles wide, from east to west and some forty miles long.

(2) That the auriferous rocks are bent into a synclinal fold, with a north and south axis.

(3) That the auriferous quartz reefs occur about the middle of the schist band and are parallel to the layers of the schist, and hence strike north and south.

(4) That the Champion lode, which occurs on the east central portion of the belt, dips west at an angle of from 45° to 60°. Probably the average dip is about 45°, and this seems to be the opinion of the managers of the Mysore Mine who expect to cut the reef at a depth of 2,000 ft. in a vertical shaft (Edgar shaft) sunk 2,000 ft. west of the outcrop.

If, then, one set of geologists are correct in their conclusions, it follows that the reefs met with in the Kolar goldfield cannot go deeper than the synclinal; and as the Champion lode occurs about the middle of the schist band, and as its dip is coincident with the bedding of the schists (an angle of 45°), it is clear that it will not extend downwards in depth indefinitely.

IMPROVEMENTS ON THE PARIS UNDERGROUND RAILWAY.

OUR readers will remember the panic and disastrous loss of life which followed the serious fire on the electric trains of the Metropolitan Railway, Paris, some months ago. It is now interesting to learn that the officials of the Paris Metropolitan Railway have decided to abandon the use of power cables carrying large high tension currents through the train, and have awarded a contract to the French Westinghouse Company for the supply of 100 complete equipments of their electro-pneumatic turret type control apparatus to replace the present system. One of the chief features of the electro-pneumatic control system is that compressed air is employed instead of high tension current for actuating the controllers on all motor cars, and that the control is effected by very low currents in wires throughout the train at the harmless pressure of 14 volts.

After a very careful study of all available systems, the engineers of the Paris Metropolitan have adopted the Westinghouse apparatus because it entails by far the least fire risk, and has many other points of superiority both from the point of view of safety and satisfactory operation. Londoners will be interested to know that one of our London railways has set the pace, and that Paris is following the example of the Metropolitan Railway (London), which adopted the Westinghouse system for the operation of their trains nearly a year ago.

BOOKS OF THE MONTH.

"BRITISH INDUSTRIES."

A Series of general Reviews for Business Men and Students. Edited by W. J. Ashley, M.A., Professor of Commerce in the University of Birmingham. Longmans, Green and Co. 5s. 6d. net.

In this volume ten lectures are included which should be of material value to business men. They were written before the fiscal question became acute, and some of the contributors take one side, some another. Mr. S. S. Jeans, editor of the *Iron and Coal Trades Review*, leads off with an instructive paper on The British Iron and Steel Industries, and other items likely to be of special interest to our readers include "The Midland Iron and Steel Wages Board," by Mr. Daniel Jones, J.P.; "British Railways as Business Enterprises," by Mr. Charles H. Grinling; "British Shipping and its Present Position"; by Mr. B. W. Ginsburg, LL.D., and "The Trust Movement in Great Britain" by Mr. H. W. Macrosty.

"STRENGTH AND ELASTICITY OF STRUCTURAL MEMBERS."

By R. J. Woods, M.E., M.Inst.C.E. Edward Arnold. 10s. 6d. net.

Intended originally for the students of the Royal Indian Engineering College at Cooper's Hill, these lectures are now available to a wider circle, and are presented with numerous diagrams and illustrations, which should prove of the utmost value. Suitable examples are given to enable the student to test his adequate comprehension of the principles explained in the various chapters, which are as follows: Graphic Statics, Stress and Strain, Stress-strain Diagrams, Working Stress, Resilience, Compound Stresses, Bending Moments and Shearing Forces, Moments of Inertia, Girders, Deflections of Beams, Bending and Direct Stress, Non-axial Loads, Stress at a Plane Joint, Masonry Structures, Columns and Struts, Riveted Joints, Continuous Girders, Cantilever Bridges, Suspension Bridges, Arched Ribs, Torsion.

"ENGINE TESTS AND BOILER EFFICIENCIES."

By J. Buchetti, some time Professor at the Central Technical School, Paris. Translated and edited from the Third Edition by Alexander Russell, M.I.E.E. Constable and Co., Ltd. 10s. 6d. net.

This careful translation of Buchetti's standard "Guide pour l'essai des moteurs" has been undertaken in order to give English and American engineers an opportunity of comparing the best Continental practice with that in use in their own countries. The author mentions that he has made numerous additions to the third addition of the work, notably in those parts which are concerned with the theory of indicators, the analysis of the working of their various parts, the description of the new apparatus, such as indicators with exterior springs for use with high-pressure engines, or when the steam has been superheated, explosion recorders for gas, petrol or alcohol engines, apparatus for reducing the scale of the reciprocating motion and the methods of setting it up, apparatus for verifying the flexibility of the springs of the indicators, etc. He has also made some additions to the chapters on brakes. The work has many excellent diagrams.

"GEOMETRY FOR TECHNICAL STUDENTS."

By E. H. Sprague, A.M.Inst.C.E. Crosby, Lockwood and Son. 1s. net.

A small book, which should be of much value to the student of engineering. The author treats with his subject in about sixty pages, but nothing of an essential nature is omitted; his explanations are concise and explicit, and the many diagrams serve to simplify the propositions.

"THE PRACTICAL ELECTRICIAN'S POCKET BOOK AND DIARY, 1904."

Edited by H. T. Crewe, M.I.Mech.E. S. Rendell and Co. and Dawbarn and Ward. 1s. net.

This handy little book is now in its sixth year of publication. The present issue has been carefully revised, but in carrying out the revision the editor has kept in view the original design, to maintain explanatory and advisory remarks on various matters in the simplest form possible. It is compact and well illustrated, and should be a very welcome companion to every practical electrician.

"THE 'DAILY MAIL' YEAR-BOOK, 1904."

Edited by Percy L. Parker. The Amalgamated Press, Ltd. 1s. 6d. net.

The "Daily Mail" Year-Book for the present year is considerably larger than previous issues. A number of new features have been added, amongst which we notice brief articles on "Steam Turbines and Speed," "Conquering the Air," "The Motor Car," "How to Obtain a Patent," "Progress of Wireless Telegraphy," etc. An admirably arranged index enhances the value of this popular work of reference.

"ELECTRICAL ENGINEERING."

An Elementary Text-book. By E. Rosenberg. Translated by W. W. Haldane Gee, B.Sc., A.M.I.E.E., and Carl Kinzbrunner. Harper and Brothers.

This treatise, written by an electrical engineer and from an engineering point of view, is based on a number of lectures delivered to the workmen and staff of a large electrical manufacturing firm, and should be extremely useful to elementary students. The idea appears to have been to present the subject in the easiest possible language; though this, of course, has necessarily involved a much larger outlay of space than would otherwise have been required. The work has a wide range, including typical dynamos and motors, accumulators and their apparatus, measuring instruments and electric light. It differs from others of an elementary character, in the space that is given to alternating current electrical engineering. The machinery illustrated is mostly German.

Owing to pressure on our space, a number of book notices are unavoidably held over.

OUR DIARY.

December, 1903.

21st.—The Legislative Council decides to appoint a commission to enquire into the whole question of Asiatic trading in the Transvaal.

22nd. — The Parisian Press Association award 60,000 fr. to Madame Curie for the continuation of her researches into radium, and 40,000 fr. to M. Branly for his labours in connection with wireless telegraphy.—The L.C.C. authorises the expenditure of £90,000 for the electrification on the conduit system of the tramway between Kennington and Streatham.

23rd. —The *Times'* Johannesburg correspondent reports that not only has the Transvaal revenue received a great set-back, so that there will probably be a serious deficit at the end of the financial year, but as regards labour, the country has failed to reach a return to the conditions of things existing in 1898.

24th.—Issue of the first part of the Indian Irrigation Commission report. The Commissioners are of the opinion that the whole of India can never be protected against famine by irrigation alone, but irrigation can do much to restrict the area and mitigate the intensity of famine.—It is reported that Sir A. Jones's recent visit to Belgium has not been successful in securing a continuance of the present service of English steamers from Antwerp to Boma.

28th.—Death of Sir William Allan.—The debate on the Chinese labour question begins in the Legislative Council at Pretoria.

29th.—Issue of a Parliamentary paper showing the aggregate naval expenditure, revenue, tonnage of mercantile marine, imports and exports of all the principal countries of the world in the year 1902.

30th.—The Argentine warships, recently reported to have been sold to an unnamed purchaser, have, it is now announced, been bought by the Japanese Government.—Launch of the *Erthogroal*, a yacht for the Sultan of Turkey, at Elswick.—Appalling fire in a Chicago theatre.

January, 1904.

3rd.—It is definitely ascertained that the total number of those who lost their lives in the Chicago Theatre fire was 587.

4th.—Opening of a new railway line in Yorkshire between the Midland Station, Leeds, and Robin Hood.

5th.—Sir Oliver Lodge lectures in Birmingham on radium.

6th.—Draft ordinance to regulate the introduction into the Transvaal of unskilled, non-European labourers published in Pretoria. It provides that the introduction of Chinese labourers shall be permissible only under licences granted by the Government, with the express stipulation that they shall be restricted to the exploitation of minerals.

7th.—A boiler explosion on board the third-class cruiser *Wallaroo* causes a number of deaths and injuries.—Fatal explosion at St. Helen's Colliery, Workington, caused by a miner firing a shot in the face of the main band.

8th.—The mail steamer *Clallam* founders off Smith Island, Victoria—about fifty lives lost.

9th.—Last day of the conference of teachers and others interested in the work of secondary schools and technical institutes, held under arrangements made by the Technical Education Board of the London County Council.

11th.—Mr. Seddon invites the Premiers of the Australian Commonwealth, Canada, Cape Colony, and Natal to unite in sending a protest to the Imperial Government against the introduction of Chinese into the Rand mines.—A special delegate conference of the South Wales Miners' Federation, convened to consider the distress caused by the stoppage of many collieries owing to the coal tax, unanimously adopt a resolution protesting against the renewal of the scheme in the coalfield for contracting-out of the Workmen's Compensation Act.

12th.—The electrification has been completed of a further section of London County Council's tramways—namely, the lines extending from St. George's Circus to New Cross and Greenwich.

13th.—The Governments of Canada and Natal refuse to join in Mr. Seddon's protest against the introduction of Chinese labour into the Transvaal.—Private inspection of the completed works of the new "tube" railway.—Destructive firing of a gas main in Piccadilly.

14th.—Sir Douglas Fox, at a meeting of the London Traffic Commission, expresses himself in favour of the constitution of a new and permanent tribunal for dealing with railway and tramway schemes in the metropolitan area.

15th.—Announcement that electro-gas signalling plant is shortly to come into operation on the main line of the North-Eastern Railway Company.—A special committee of the Institution of Mechanical Engineers present final report dealing with the study of steel alloys.

17th.—The bursting of a reservoir causes loss of life and great destruction of property in Bloemfontein.

18th.—An important convention of the United Mine Workers of America opens at Indianapolis.—The officials of the Paris Underground Railway decide in favour of electro-pneumatic turret type control apparatus.

19th.—The Secretary for Scotland receives a deputation of Scottish scientific societies, who urge that the Royal Institution in Edinburgh should be exclusively devoted to scientific purposes.

20th.—Lord Milner, at Krugersdorp, receives a deputation of farmers, whom he addresses on the subjects of agriculture and the importation of Chinese labour. He says the revenue is declining because the principal industry of the country is working at only half its strength.

CALENDARS, NEW CATALOGUES AND TRADE PUBLICATIONS.

The Brush Electrical Engineering Company, Ltd., have issued an artistic desk calendar, the monthly sections of which are enclosed in an embossed linen-covered frame with foliated design.

The United States Metallic Packing Company send us a good practical calendar with tear-off dates nearly 3 in. in length—a boon to the short-sighted and a constant reminder of their telegraphic addresses, etc.

Messrs. Partridge and Cooper issue a calendar in twelve sections, approximately 6 in. by 8 in. Its chief merit is clearness of typography and arrangement. They also send a useful sheet calendar suitable for hanging on the wall. Each section presents not only the days of a particular month, but also a calendar of the entire year.

Messrs. Henry Good and Son, of 12, Moorgate Street, E.C., forward a neat desk calendar, the monthly sections of which are attached to an embossed blue and gilt card.

Considerable pains have been taken by Messrs. W. T. Glover and Co., Ltd., to make their second annual tear-off sheet calendar useful to professional men. The reading matter is mostly compiled from the Proceedings of the Institution of Electrical Engineers and the Incorporated Municipal Electrical Association. Photographs of prominent electrical engineers are included, and on the back of the calendar appears some data likely to be required for everyday use.

J. F. Bennett.—A calendar issued by this firm has a novel arrangement by which, instead of tearing away the dates in rotation, an adjustable sliding frame brings the dates consecutively into prominence.

A useful sheet calendar also reaches us from Messrs. Henry Good and Son, of 12, Moorgate Street, E.C.

Messrs. M. Glover and Co. are calling attention to their specialities by means of a circular glass paper-weight. This is a handy arrangement which is not likely to be thrown away.

Mr. E. Arnold Pochin, specialist in gearing and gear cutting, has included some useful technical information in his wall calendar, the dates of which, printed in red and black, stand out in bold relief.

Messrs. Walter Johnson and Co., Ltd., of 67 and 68, King William Street, E.C., forward a comprehensive wall calendar, the sheets of which are effectively printed in three colours.

Messrs. British Steam Specialities, Ltd., forward a leather-bound pocket diary. In addition to calendar and space for memoranda each day, the diary has a quantity of useful information—postal, engineering, and general.

Messrs. C. W. Hunt Company, West New Brighton, New York.—Pamphlet No. 037 gives an excellent idea in brief of their steeple powers, Parabolic boom towers, Hunt elevators, overhead trolleys, coal tubs, automatic railways, cable railways, etc.

British Thomson-Houston Company, Ltd.—Pamphlet No. 163 describes and illustrates the B. T. H. Edison incandescent lamps, and supersedes No. 135, issued December, 1902. It can with advantage be filed for reference. The latest information regarding their Multiple Unit System of Train Control for Electric Railways is compressed in a twenty-four page booklet, which shows the system in use in various parts of the world. The company have been well advised to bind these attractive sheets in a stiff cloth cover.

The Bullock Electric Manufacturing Company send us a well-printed list of their type "B" motors and generators, with illustrations and tables of ratings.

The Oliver Typewriter Company are issuing their calendar in the form of monthly postcards, which, judging from No. 1, will be worthy of careful preservation. The series will be entitled "The Art of Writing through the Century," the January calendar commencing with cuneiform inscriptions. These cards are calculated to make a cheerful addition to the paraphernalia of the desk, and will be especially welcomed by the collector of pictorial postcards.

Messrs. Walter Judd, Ltd., Advertising Contractors, have issued a striking sheet calendar in red, white, and blue. The days of the week are clearly indicated in white on a blue ground, and the dates are also thrown into strong relief, while each month's instalment of the calendar presents a view in brief of the entire year. An excellent effect is obtained by enclosing the calendar in a red border.

The Wilber H. Murray Manufacturing Company, Cleveland, Ohio, U.S.A.—An attractive catalogue of the well-known "Murray" Vehicles, comprising carriages, phætons, omnibuses, trade vehicles, harness, etc. The cover is of elegant design, and is in the form of a long strip which folds over the outside edges of the catalogue to which it is attached by a brown silk cord.

Tangyes, Ltd., Cornwall Works, Birmingham.—Catalogue No. 60, well printed and illustrated, supersedes all former lists of steam engines. The following is a synopsis of contents: Horizontal, "Colonial," "Soho," Vertical and "Archer" Steam Engines, Cross Compound Steam Engine, Tandem Compound Steam Engine, Compound "Archer" Steam Engine, Sundries for Engines, Examples. A price list of unrevised machinery at present in stock is also issued by this firm. An introductory note informs us that the machinery specified in this list is, for the most part, an accumulation consequent upon the complete revision of the manufactures of Tangyes, Ltd. In almost every case, the articles are of Tangyes' manufacture, the few exceptions being specially mentioned.

Messrs. Mellowes and Co., Ltd., Sheffield and London, issue a catalogue printed on art paper, with some exceptionally good illustrations of their "Eclipse" roof glazing. From the first of these we note that 100,000 superficial feet of this glazing was used on the Central Transept of the Crystal Palace in 1899-1900.

Messrs. H. J. H. King and Co., Newmarket Engineering Works, Nailsworth, Gloucestershire, send a quantity of information relating to their patent clutches (King's Patents), including illustrations, tables, prices, weights and sizes in cases. The second part of the catalogue is devoted to turbine, turbine governors, steam engines, etc.

J. Parkinson and Son, Canal Iron Works, Shipley, Yorks.—In sending seasonable greetings for 1904, this firm recommend as a motto for the year "Efficient Equipment," and in connection therewith illustrate their "Perfect" vice, and slogging or high-speed lathe.

Messrs. R. Waygood and Co., Ltd., Falmouth Road, London, S.E.—Those who are in search of points on the electric lift cannot do better than obtain a small pamphlet which has been issued by this firm. It deals adequately with the Vee Sheave Drive drum driving for passenger lifts, American experience, the duration of ropes, etc.

Specially taken for PAGE'S MAGAZINE.] [*Elliott and Fry.*

MR. JOHN GAVEY, C.B., M.INST.C.E., M.I.E.E., ENGINEER-IN-CHIEF AND ELECTRICIAN TO THE BRITISH POST OFFICE.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining and Allied Industries.

VOL. IV. LONDON, MARCH, 1904. No. 3.

FIG. 21. GENERAL VIEW OF WORKMEN'S VILLAGE, SCHLAEGEL AND EISEN COLLIERY.

NOTES ON THE WESTPHALIAN COAL FIELD.

BY

DAVID A. LOUIS, F.I.C., M.I.M.E., M.A.I.M.E., F.C.S.

IV.

IN previous numbers of this Magazine the writer considered the topography, geology, and the character of the coal seams of the Westphalian coal field, also the conditions incident to a production of 60,000,000 tons from that field, so far as related to the methods of working, means of transport, arrangements for winding, and appliances for draining; leaving such matters as ventilation and incidental factors; the preparation of the produce for market and its disposal and business and labour considerations for treatment in the present article. The regulated output has since been raised to 65,000,000 tons a year.

VENTILATION.

Under this head will be considered: The natural atmosphere of the mines, the inherent temperature, and the means employed to control these inconveniences.

The atmosphere encountered in the Westphalian mines is decidedly bad and gassy. The gassy character is affected by two circumstances, the position of the coal in the field and the character of the coal being worked. Those mines working out-crop coal, indicated at A on the map on page 484, vol. III., were much freer from gas than those mines working coal under the marly over-burden indicated at C on the same map. In fact, out of seventy-eight out-crop mines only six yielded more than 140 cubic feet of gas per ton of coal, and these were not only situated in proximity to the marly over-burden, but they were working the most gassy coal seams. Whereas of 132 mines working coal under the marls, 72 yielded 140 cubic feet and upwards per ton of coal. But more noteworthy still is the effect of the character of the coal being worked on the atmosphere of the mines; the fat bituminous

FIG. 17. MINERS PROTECTED BY THE STOLZ SMOKE MASK.

coal seams yielding most gas, the gas and flaming coals coming next and the lean coals emitting the least.

Of 55 mines working in the latter seams, 30 gave below 17 cubic feet of gas per ton of coal, and none gave over 105 cubic feet; in the fat bituminous coal seams there were 119 mines working, and of these only 8 gave less than 17 cubic feet, quite a number gave quantities varying from 70 to 420 cubic feet, several gave even more. Amongst the highest were Gneisenau with 1,400, Hibernia with 1,800, Grimberg with 1,977, and Dahlbusch II. with 2,380 cubic feet of gas per ton of coal mined. Turning to the flaming and gas coal seams of 36 mines, 6 gave less than 17 cubic feet, 25 gave quantities varying from 17 to 420 cubic feet, and 5 yielded volumes between 420 and 700. Blowers are not infrequent and the gas is utilised in many mines; at Hansa Colliery, for instance, to light the pit eye, and at Consolidation Colliery for warming the compressed air where used for power purposes.

The Westphalian mines are amply provided with airways. Some very gassy mines are even provided with double airways, and in those subject to blowers special provision is made for driving this excess of gas direct into the return airway. Only 10 mines had less than 1,100 yards of airways, whilst 5 had more than 8,750 yards, the remaining mines had lengths of airways intermediate between these extremes. Air splitting, so as to give different parts of the mines their own supply of fresh air is, of course, in vogue, and the air currents are conducted to the working faces by various means to suit circumstances: By dividing walls, by masonry conduits, by air-boxes, by brattice, by special fans, by compressed air either employed in working drills, etc., or specially provided for ventilative purposes. There were some 434 ventilating shafts on the field, 43 were divided to serve both for up—and down—cast, 190 served for downcast only and the rest for upcast only; of the latter many were in use for drawing coals, and in those instances various contrivances were in use to prevent leakage of air, such as: Briart's shaft cover; air-locks with double doors and the Neumühl arrangement referred to in the January number, pages 38-41.

The currents were generated by fans; of old types the Capell, of new ones the Rateau fan being mostly in use, and these were being driven in some cases by electricity but mostly by steam engines. As a matter of course the quantity of air required varies very considerably in different mines, but the object is to keep the gas below one per cent. in the returns; in fact no mine exceeded this, and by far the preponderating number kept the gas content of the returns well below half that amount. The speed of the currents did not generally exceed 20 ft. a second, nevertheless a good many exceeded this rate and 28 even maintained a rate of over 26 ft. The equivalent orifice varied from under 1 square yard to above $4\frac{1}{2}$.

In Table I. are set forth numbers showing the extremes relating to the air supply in different mines in 1900.

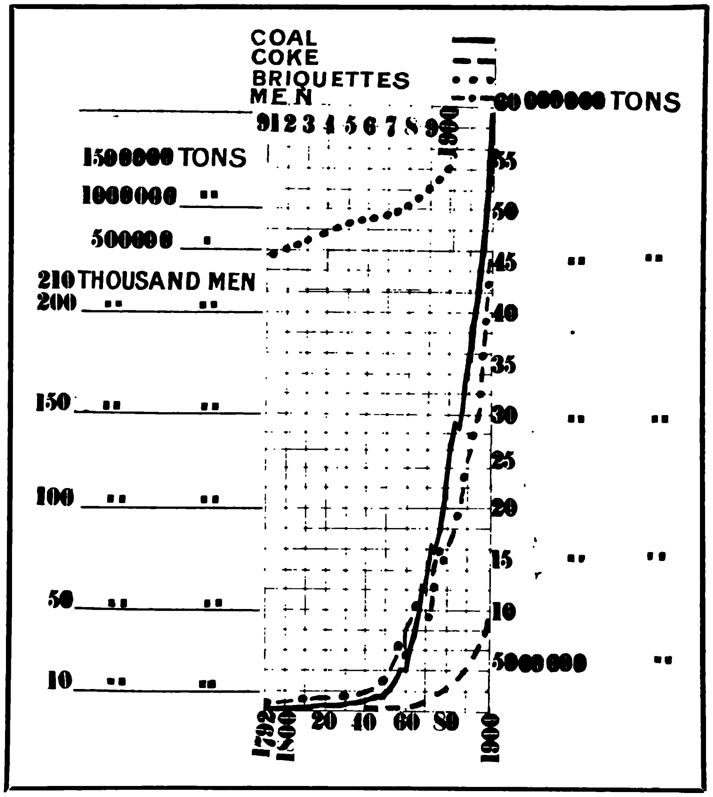


FIG. 18. OUTPUT DIAGRAM.

TABLE I.

AIR CIRCULATION IN WESTPHALIAN MINES.

Cub. ft. air per min.	No. of mines.	Cub. ft. air per man per min.	No. of mines.	Cub. ft. air per ton drawn.	No. of mines.
Below 17,560	22	Below 70 ...	0	Below 35 ...	10
Above 211,800	3	Above 350 ...	4	Above 280 ...	2
Intermediate	185	Intermediate	206	Intermediate	198

The natural temperature of the mines in Westphalia increases as is the case elsewhere with the depth, and the result of observations is set forth in Table II. The increase, on an average, being 1 deg. F. for each additional 8 fathoms. This temperature, of course, has to be kept down, and it is kept down by ventilation. In many cases where the heat greatly impeded work, improved ventilation has rectified the inconvenience: a good instance of this occurred in Hansa Colliery, where a temperature of 84 deg. F. existed, and it was only possible to work six-hour shifts, but by judicious air-splitting the temperature was reduced to 76 deg., and work could be endured for the normal number of hours.

TABLE II.

TEMPERATURE IN WESTPHALIAN MINES.

Depth in fathoms.	Degrees Fahrenheit.
108	59
164	65
218	72
273	78
328	85
383	91
437	98
492	104
547	111

DUST.

This is a point that those who mine in Westphalia dare not overlook. The tendency to produce dust is influenced to a certain extent by the caking character of the coals. The fat coals are more prone to form dust than the gas and flaming coals. The lean coals can also give rise to plenty of dust, but, generally, these

seams have sufficient natural moisture to keep the dust down. Inclined seams give more dust in working than flat seams. The dust from any of the seams can cause explosion if fine enough, but the dust from the fat coals is the most dangerous. It is therefore realised in Westphalia that the dust must be dealt with wherever coal is mined.

SPRINKLING.

To keep the dust down a considerable amount of sprinkling is therefore done in the mines, and this becomes quite a formidable item of expenditure as well for the maintenance of the system of pipes itself as for repairing damage done to roads by the water. In 1900 there were 2.500 miles of sprinkling piping under ground, and in one mine alone, Consolidation, there were 79 miles of pipe which cost £18.000. The cost of sprinkling varied from 8¾d. to 21⅓d. per ton of coal mined for the year: the great difference between the lowest and highest, of course, was due to more renewals, etc., in one case than in others, an average cost for sprinkling was between 11d. and 14d. per annum per ton of coal mined.

The quantity of water used for this purpose, the special arrangements and the men employed in the sprinkling are quite noteworthy. In one of Bergrath Behrens' mines, Hibernia, where 850 tons of coal were drawn a day, 1.000 cubic feet of water were used in sprinkling all open roads and 126 working places. The roads were sprayed by special men, giving employment to ten men in the morning shift and three in the afternoon, no road spraying being done in the night shift: and the spraying in the working places being done by the miners themselves. Smiths were also employed constantly at repairs. Mine water was, in the Hibernia mine, used for spraying, and was taken off from the pumps at a convenient level, where it was stored in a tank and gave a water column equivalent to 27 atmospheres pressure in the shaft, which became from 8 to 18 atmospheres at points of application. The water was distributed by galvanised wrought-iron pipes tested to 60 atmospheres, and there were 524 yards of piping 3⅛ in. internal diameter, 2.050 yards 2 in., and 53.270 yards of 1 in. There were 1.169 hydrants connected to the pipes at intervals of 160 ft. apart along the roads, a distance to be reduced, inasmuch as it necessitated 60 to 80 ft. of flexible rubber hose, which has to be stout enough to resist the pressure and such a length is therefore very heavy for the sprinklers to drag about the roads: shorter lengths were in use at the working faces; a jet was used at the end of each piece of hose. The system of piping was provided with 574 stopcocks, so as to shut off any part if not required, or for repairs or for lengthening. The cost of the installation and material for this sprinkling plant was £68.125, whilst over £1,171 a year was being spent on its supervision and maintenance. In another mine 1.900 cubic feet of water was used with six master sprinklers and six smiths at work in the morning and afternoon shift, and two sprinklers in the night shift for an output of 1.000 tons a day.

EXPLOSIVES, EXPLOSIONS AND SAFETY LAMPS have such a great influence on the safety of mining operations that a word or two must be said about them. In 1900 safety explosives had replaced others in Westphalia, except in a few mines working the lean coal seams and the gas coal seams where black powder was still in use. Fuses, even safety fuses, were being replaced by electric firing. For lighting the pit bottom and stations incandescent electric lamps were generally employed, portable electric lamps, except in connection with rescue appliances, were not in use. Single-gauze safety lamps, of the Marsaut type, with re-lighting arrangement, made by Friemann and Wolf, to burn benzine were the most prevalent working lamps. It is satisfactory to note that at the time of the writer's visit to the district, although the output had been increasing, there was a diminution in the number of explosions as well as in the number of fatalities arising therefrom; this is attributable to many of the precautionary measures already noted: improved ventilation,

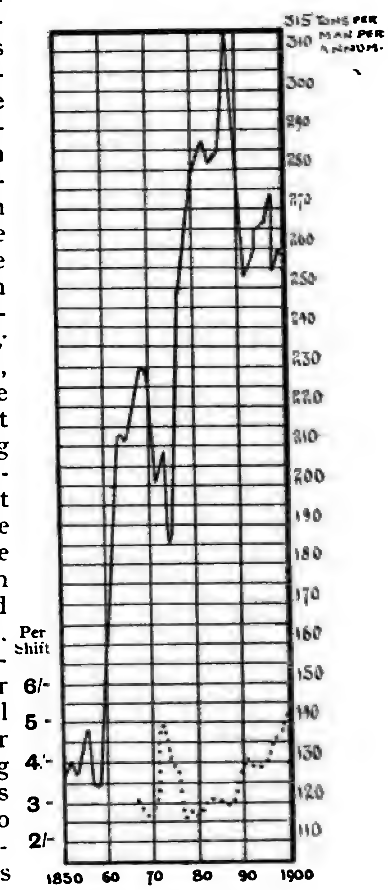


FIG. 19. LABOUR AND WAGES DIAGRAM.

FIG. 20. WASHING AND CHANGING HALL, SHAMROCK COLLIERY.

sprinkling, safety explosives and electric firing. It is noteworthy that most elaborate appliances are always kept in readiness for rescue work, for protection from fire and for combatting fire: men, moreover, are constantly kept drilled in the use of these appliances. These departments, in fact, form quite remarkable features at most of the mines and make quite striking displays, the medical department with operating tables, medicine chests and surgical appliances; the rescue department with respiratory apparatus and special clothes to enable men to go into smoky or other bad atmospheres, stretchers, etc.: these were particularly good at Shamrock mine, another of those under Bergrath Behrens' management. In fact, there was an excellent exhibit of this description from this mine at the Düsseldorf Exhibition: moreover, the writer had an opportunity of witnessing the thoroughness with which the practice is carried out. Men appropriately clothed and equipped with pneumatophors were sent into a room hermetically closed, but provided with windows for inspection, and with a pernicious smoky atmosphere to make the practice realistic. The practice consisted in the search for injured and other companions, their treatment and removal to a place of safety. The extinction of fire underground, the removal of debris and the setting of timbers and restoration of order in the disturbed working. The type of pneumatophor used in the case referred to was provided with two cylinders of oxygen carried low down on each man's back and a respiratory sack in front into which a solution of caustic soda had been tipped to absorb the products of respiration. Two cylinders of oxygen were used, so as to warn the man when one gives out that half his store was exhausted. Fig. 17 shows men protected by the Stolz smoke mask building up a place in a bad atmosphere. The fire-brigade department, with their showy appliances kept in perfect order, form distinctly attractive looking adjuncts to many a colliery in the neighbourhood.

PREPARING THE COAL FOR MARKET.

Only a very small proportion of the coal raised in Westphalia can be profitably placed on the market directly as it comes from the mines. It is therefore subjected to some sort of preparatory treatment either to improve the value of good stuff or to render the useless useful; the means employed are screening and picking or the more elaborate washing, and much of the output in the form of finely divided coal is subsequently coked or made into briquettes. The washing plants used are mostly either those of Humboldt of Kalk, near Cologne, or of Schüchtermann and Kremer of Dortmund or of Baum of Herne. The latest installations of the last-named maker were being arranged to wash the coal without previously separating into different sizes as had hitherto been the practice, the washed coal being sized subsequently. Such an arrangement would require fewer jigs, less water, and less power, and would entail a simpler and less expensive plant.

About 9¾ million tons out of the sixty million tons of coal mined was recovered in the form of mud from the washeries and was subsequently converted into coke and briquettes.

Coke making is an industry that has been showing steady progress in Westphalia. All stages of the practice have been passed through: heaps, mounds, stacks and various forms of the bee-hive ovens, but all these have long been discarded and chamber ovens are now exclusively used. The prevailing type of oven

was the Otto-Coppée and in various forms some six thousand of them took part in the production of the millions of tons of coke in 1900. But other systems have also been introduced, including those of Collin, von Bauer, Brunck, Koppers, etc. An important factor in connection with the coke ovens is the recovery of by-products, a factor which is not neglected in the district under notice so that in the year, 1900, 12,000 tons of benzol were recovered from the by-products, and more than 77,000 tons of tar and a little over 36½ thousand tons of sulphate of ammonia. Besides these 1,530,000 tons of briquettes were produced in ninety-two presses, for this purpose only the fines from washing the leaner or semi-bituminous coal mixed with pitch were used.

CHARACTER OF THE PRODUCE.

Thirty per cent. of the output of the field was gas ~~and~~ flaming coal, fifty-seven per cent. fat and bituminous coal and thirteen per cent. lean coal.

The gas coal and the flaming coal burn with long flames and are comparatively strong and hard, which renders them suitable for storage and transport. The gas coal, as the name signifies, contains much gas, and is almost exclusively used for gas-making. The flaming coal is suitable for any purpose where a good flame is wanted; in the domestic hearth and in the puddling furnace for example. The fat coal also burns with a long flame and is a good heat producer, but it is particularly distinguished by its great caking properties which renders it eminently suitable for coke making. It is also in demand for many other purposes. The lean coal burns with less smoke and soot than the fat coal, and therefore is suitable for use in textile and other industries where smoke is undesirable; the fine coal produced in the washing operation in this case is that used in the manufacture of briquettes. These briquettes stand storage well, the pitch protecting them from absorbing moisture; moreover, their rectangular shape and uniform size render them good for transport. They are largely used on locomotives, steam ships, in dwelling houses, and are replacing flaming coal in iron works, sugar factories, glass works and porcelain and cement mills. Over 13¾ million tons of fine coal was used in the production of coke and briquettes.

Fig. 18 shows the development of the coal, coke, and briquette industry in the Westphalian field from the earliest time up to the commencement of this century. In the figure vertical lines refer to the years, the horizontal lines to quantities. The tonnages to the right of the figure relate to coal and coke, those to the left of it to briquettes, on this side the numbers relating to men employed are shown. We see in the early days the production was quite small, it was less than two million tons, and employing less than 10,000 men up to 1840; but it progressed steadily until 1850, when the iron industry awakened into activity, and this, with the extension of railways, exerted a marked effect on the Westphalian coal output, which since 1860 has continued to increase vigorously, until in the year more particularly referred to in these notes, it amounted to nearly sixty million tons of coal and 9⅔ million tons of coke and considerably over 1½ million tons of briquettes; and that the number of workmen employed approached 228,000. It will be noticed how the labour curve varies with the output; moreover, that coke first appears about 1841 and briquettes only fifty years afterwards, that is, in 1891.

DESTINATION OF THE PRODUCE.

Without going into details of the different localities, Table III. sets forth the destination

TABLE III.

WESTPHALIAN EXPORTS.

District.	Million Tons.		Briquettes in 100,000 tons.
	Coal.	Coke.	
Neighbourhood	29⅔	3⅙	7⅝
Elsewhere in Germany...	9⅓	3⅓	7⅜
Abroad	4	2⅙	¼
Total sent from Collieries, etc.	43	8⅚	15¼

of the produce for the year concerned. Most of this went away by rail but about seven million tons were carried on the Rhein from the ports of Ruhrort, Duisberg and Hochfeld, whilst 54,000 tons found their way down the Dortmund Ems Canal.

The business departments of these great mines are naturally not without interest. It is well to remember that up to 1851 they were entirely under the control of the State; the Mining Office decided which collieries should be worked and what production each should yield and fixed the selling price. Want of railway communication at that time restricted the market within quite narrow limits, and hence the

smallness of the consumption indicated in fig. 18 is readily explained. But in 1851 a new law came into operation, allowing private parties to work the mines, and so although there were only 205 mines in 1854, 298 were at work in 1857. The output, which was worth £500,000 in 1851, was worth £1,640,000 in 1858, whilst after the Franco-German War the value of the output rose considerably, reaching £7,900,000 in 1874, and prices had risen from 5s. 3d. a ton in 1869 to 11s. a ton. This state of things did not continue, and in 1879 the price had got back to 4⅞s. per ton. So the district has had its periods of prosperity but has also had periods of adversity, when many mines were carried on at a loss. Of late years three organisations have handled the produce of the district, and fixed the output of each of the collieries concerned, the "Rheinisch-Westfälisches Kohlensyndikat" dealt with 87·4 per cent. of the entire output of the field, the rest of the output was mostly derived from collieries belonging to one or other of the great iron companies who consumed it themselves. The "Westfälische Kokssyndikat" in the same way dealt with 98·5 per cent. of the coke produced, whilst the third syndicate disposed of the whole output of briquettes. This arrangement insures a certain regularity in the prices obtained, and better prices which are constantly improving have ruled since the syndicates have had the matter in hand, and many of the mines have been able to pay magnificent dividends. The cost of production is dependent on various circumstances, and, therefore, the actual cost of the coal at pit mouth is different at different collieries, but the average was about 6s. or 7s.

The collieries are worked some by companies and some by corporations. Twenty-nine of the companies, representing a capital of £22,807,600, and paying £5,696,950 per annum rent, etc., each produced over 200,000 tons of coal in 1900, or, altogether, 34,724,000 tons. The smallest of these worked an area of 772 acres with a capital of £150,000; the greatest of these companies worked an area of 41,688 acres with a capital of £2,700,000, and produced 5,460,000 tons, this is the "Gelsenkirchener Bergwerks-Aktiengesellschaft." The next largest outputs, 5,187,000 and 3,423,000 tons, respectively, were those of the "Harpener Bergbau-Aktiengesellschaft" and of "Hibernia," working, the one 30,704 acres with a capital of £2,600,000, the other 16,022 acres with a capital of £1,890,000. The "Harpener Bergbau-Aktiengesellschaft" worked seventeen pits with 20,500 workmen and 715 officials great and small. The largest corporation property was the Zollverein, working an area of 5,407 acres and putting out 1,753,000 tons of coal; whilst the smallest of these areas producing over 200,000 tons was 254 acres.

LABOUR.

The relation of the labour employed to the output is set forth in fig. 18, and shows with some clearness that the number of men employed increases with the greater output. Naturally enough, as the prosperity of the district grew more rapidly than the indigent population a great number of men are drawn from outside, mostly coming from Prussian Polish provinces, but others coming from various foreign countries, many not being able to speak German, but no important work involving risk is entrusted to any who do not speak and understand German. People over sixty or lads under sixteen are not allowed to work underground. The underground shifts are eight hours each, but on the surface eight to twelve hour shifts are worked, exclusive of time occupied in reaching and leaving work; fig. 19 shows the hewers' earnings per shift and also tonnage per man per annum. In this figure, again, the vertical lines indicate years, the horizontal quantities. The tonnage per man per year in other German coal districts in 1900 was 346 in Upper Silesia, 213 in Lower Silesia, 227 in the Saar

FIG. 22. STORE AND A PORTION OF THE VILLAGE, SCHLAEGEL AND EISEN COLLIERY.

district, so Westphalia holds its own all right. It is noteworthy that when averages are taken the men's wages have been steadily on the increase during recent years. The average pay of all men at the period here concerned was 3·97 shillings per shift; of hewers 4·54. With regard to accidents, nineteen deaths resulted from explosions in 1900, that is 0·1 per thousand men employed; by falls of rock and coal more accidents happened, resulting in 199 deaths, or 1·118 per thousand men, another fruitful source of accident is in the shafts and inclines, not while travelling in the cage but by the trammer running the tubs quickly to the shaft or incline, and being unable to stop the tub, it runs over the edge and draws the man with it; there were 111 fatal accidents in shafts and inclines, or 0·624 per thousand men, and mostly of this character.

The men are well looked after, excellent bathing arrangements and changing rooms, where the home clothes are left and aired while the men are at work and *vice versâ*. In these halls, each man is allotted a place, and is provided with a hook and a pulley high up near the roof, and a length of rope, by this means he can pull the hook up or let it down as desired. When he arrives he lets down the hook on which his pit clothes hang, changes, puts his home clothes on the hook, hoists it up to near the roof, padlocks the end of the rope so that none but he can get the clothes down. There he leaves them until required after the shifts work and the shower bath. Fig. 20 is a view of the changing room at Shamrock Colliery.

There is a general friendly society which embraces most of the collieries and numbers some 120,000 members; in 1899 it helped 23,163 invalids, 15,194 widows and 49,000 orphans. Its receipts were £952,082, its expenditure £728,689, and it has funds, free from debt, amounting to £1,212,741. A good feature about these collieries is the good houses the companies provide in their private villages for the miners, who go home clean, and so do not soil the home and make it unattractive as is too frequently the case in this country. Figs. 21 and 22 are views of the village recently constructed at Schlägel and Eisen Colliery.

The writer wishes, in conclusion, to acknowledge gratefully the uniform courtesy and kindness extended to him by the engineers and functionaries generally at the numerous mines he visited. More particularly, he is pleased to thank the editor of "Glückauf"; General Director Bergrat Behrens, of Bergwerksgesellschaft. Hibernia, Herne; the Harpener Bergbau-Actien Gesellschaft, Dortmund; Haniel and Lueg, Düsseldorf; the Gutehoffnungshütte A.V., Oberhausen, and Aug. Klönne, Dortmund; for photographs, etc., from which many of the figures have been reproduced.

Furthermore, for the benefit of those who may desire further information relating to this coal field, it may be noted that much of the statistical matter included in this article is to be found greatly amplified in the "Festchrift," published on the occasion of the Allgemeiner deutsche Bergmannstag in Dortmund.

OUR MONTHLY BIOGRAPHY.

Mr. JOHN GAVEY, C.B., M.Inst.C.E., M.I.E.E.,

Engineer-in-Chief and Electrician to the Post Office.

IT is safe to assert that there have been few developments in the telegraph and telephone services of the Post Office with which the subject of the present sketch has not been prominently identified. Mr. Gavey was born and educated in Jersey. He entered the service of the Electric and International Telegraph Company in 1860, and when the State assumed control of the telegraphs in 1870 his services were transferred to the Government. He acted successively as superintendent of the South-Eastern, Great Western and South Wales districts. In 1892 came the appointment of Chief Technical Officer at the General Post Office; in 1897 that of Second Assistant Engineer-in-Chief, in 1899 Assistant Engineer-in-Chief and Electrician, while in 1902 he was called upon to assume the responsibilities attaching to the post of Engineer-in-Chief and Electrician.

Mr. Gavey's career has been one of strenuous application, and he has found time for a great deal of original research. Turning to the Electrical Trades Directory we are reminded that when in Bristol he took one of the earliest steps in the direction of increasing the speed of Wheatstone working by designing the arrangement of placing the local apparatus, which indicates when readjustment of the relays of a repeater set is necessary, in a high resistance leak on the main circuit, this leak being so proportioned to the line and apparatus resistance that the current actuating the relay is about the equivalent of that received at the distant station.

A little later, on the initiative of Sir William Preece, he applied himself to the improvement of the repeaters which were placed at Haverfordwest on the Irish wires. At that time, owing to the inertia of the relaying sounders then employed, the insertion of repeaters actually decreased the speed of Wheatstone working as compared with the results obtained in fine weather on direct circuits, and they were only brought into use when the insulation conditions became such that direct working was impossible. Following up the Bristol experiment he introduced repeating direct from the relays, an alteration rendered possible by the use of leak circuits, with the result that the speed of Wheatstone signalling, instead of being reduced, was immediately doubled on the insertion of the repeaters, which thenceforth were constantly retained in circuit.

About the date of his removal to Cardiff the telephone was introduced, and he forthwith devoted his attention to this new development. The result was that by the summer of 1881 the first trunk telephone line connecting exchanges in two separate post towns in Great Britain (Cardiff and Newport) was erected and brought into use.

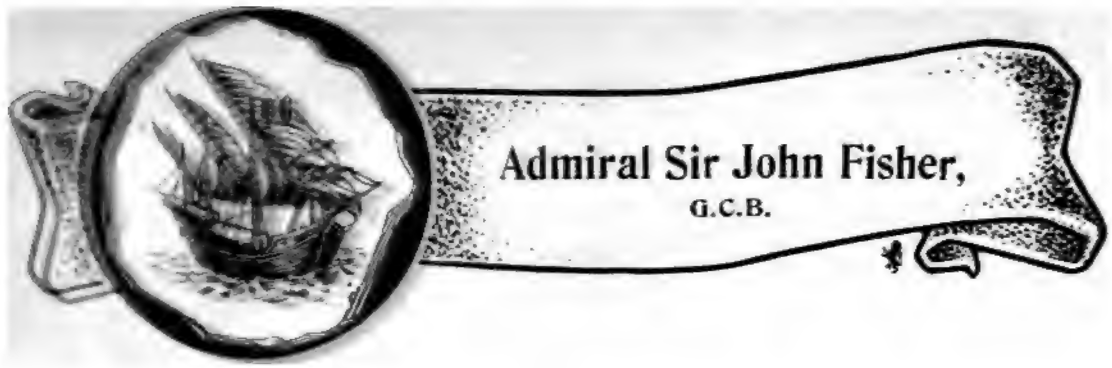
Subsequently Mr. Gavey was requested by Sir William Preece to carry out a series of experiments on wireless telegraphy, which have been described in papers read before various institutions. In the course of some of these trials Mr. Gavey obtained the first successful result in so-called "wireless telephony," having in 1899 obtained articulate speech between two parallel wires on opposite sides of Loch Ness. This led subsequently to the establishment of a permanent wireless telephonic service between the rocky islets known as the Skerries and the mainland near Holyhead.

Later, when the Post Office decided on the acquisition of the trunk telephone system in the United Kingdom, he was entrusted with the duty of valuing the trunk lines to be acquired from the National Telephone Company, and subsequently with the organisation and development of that system.

When the extension of the local service of the Post Office was decided upon, he visited various countries in Europe and America to inquire into and report on the systems in actual use, and finally he was called upon, amongst his other duties, to design and supervise the construction of the Post Office system of telephone exchanges in the metropolitan district.

Whilst in Cardiff he took an active share in the educational development of the town. He was for several years a member of the free library and museum, and of the Technical Education Committees. He was for a considerable period hon. secretary, and finally president, of the Cardiff Naturalists' Society. He has amongst other contributions, read the following Papers at the Institution of Electrical Engineers: "On Earth Borers for Telegraph Poles"; "On Insulators for Aerial Telegraph Lines"; "On the Telephone Trunk Line System in Great Britain"; "On Telegraphs and Telephones at the Paris Exhibition"; and on "Telephones" before the Society of Arts; in addition to Papers of purely local interest and contributions to the technical press. He acted as juror in the electrical section of the Paris Exhibition of 1900, and was appointed an official delegate to the International Electrical Congress which was held in connection with the Exhibition.

We may add that he attended the Wireless Telegraph Conference at Berlin as one of the British delegates. The C.B. was conferred on him in 1893 in recognition of his public service.



Admiral Sir John Fisher, G.C.B.

AN APPRECIATION BY MR. W. T. STEAD.

THE personality of Sir John Fisher has been lately more prominent than ever in connection with the scheme which Lord Esher, Sir George Clarke, and the gallant admiral, have drawn up for the reorganisation of the War Office. We have rarely seen a better appreciation of the admiral than that which is given in the current number of "The Review of Reviews," by Mr. W. T. Stead. It is a curious fact that Admiral Fisher was the last midshipman received into the service by Sir William Parker—the last of Nelson's captains.

Eighteen years ago, says Mr. Stead, when I began my investigations into the state of the navy, I was told by those who knew the service from the top to the bottom that I would find no abler officer afloat or ashore than one Captain Fisher, who had commanded the *Inflexible* at the bombardment of Alexandria, and who was at that moment captain of the *Excellent.*

I sought an introduction to him, which I obtained with some difficulty, for the rules of the service against giving any information to the press were very strict. When I used to go to Captain Fisher, like Nicodemus, at night-time, meeting him at wayside railway stations, I found him, wherever I met him, always the same—one of the pleasantest, frankest and clearest-sighted of men. "Fisher," said an admiral to me in those days, "is the one man we have got who can be compared to Nelson. If Britain were involved in a great naval war, Fisher could achieve as great renown as that of Lord Nelson." His subsequent career has fully justified the confidence expressed in him by his superior officers.

Admiral Fisher since then has commanded the Mediterranean fleet, and it is no exaggeration to say that it is largely owing to the splendid state of efficiency of that fleet under his command that the peace of Europe was maintained in the critical years when the whole land fighting force of the Empire was absorbed in South Africa. He is a supreme type of the modern naval officer at his best. Although sixty two years of age, Admiral Fisher is in the full vigour of manhood, and as hearty a boy as he was in the days when he first joined the navy in the Crimean War. When he represented the navy at the conference at The Hague, where he did admirable service, he was known as "the dancing admiral." And even now, when commander-in-chief at Portsmouth dockyard, he still thinks nothing of attending ten dancing parties in a fortnight takes part in every dance, and does not go home till three o'clock in the morning. He is brimful of vigour, energy and buoyant vitality. But for all his devotion to the dance, no man is a keener student, nor has any one a more masterly grasp of all the latest improvements in naval warfare.

He is a man born to command, who inspires confidence alike in his superiors and among his subordinates. Nelson, as may well be imagined, is the god of his idolatry. He is saturated in every fibre with the Nelsonian tradition. He has served his country on almost every naval station, he has been a sea lord at the Admiralty, and sooner or later will take his proper place as the first sea lord at Whitehall. On listening to his brilliant conversation, every sentence of which is double-shotted with wit and common sense, I have been constantly reminded of two men who, however diverse from each other and from him, nevertheless possess one great characteristic in common. Admiral Fisher, like Cecil Rhodes and General Gordon, is passionately devoted to his country, and, like them, is vehemently impatient of all the mediocrities who, shackled in red tape, exhaust all their energy in the mere detail of administration, and have neither time nor capacity left for attending to the proper work of direction. Admiral Fisher is a holy terror to skulkers and shufflers, but he has an infinite faith in the capacity of education and discipline. "Give me a boy young enough," he declared, "and I can make anything out of him." For there is in him, as in all great leaders of men, an infinite faith in the latent potentiality of human nature. He is a born optimist, and contact with him kindles enthusiasm even among the dullards. Few men have so great a gift of forcible expression; his conversation teems with apothegms. But there is a iovial geniality about him which makes every one feel at his ease. If so be that it is necessary to call in the aid of a sailorman in order to advise as to the best method of reforming the administration of the War Office, no better choice could have been made than that of Admiral Fisher.

He enjoys to an almost unprecedented extent the confidence of his King and of his country, while as for the navy, there would probably be a unanimous vote in the service if all sailormen ashore and afloat were to be asked to vote as to what great sea captain of our time was best qualified to lead the navy of Great Britain to victory in a great naval war.

From the "Review of Reviews."]

ADMIRAL SIR JOHN ARBUTHNOT FISHER, G.C.B.

(Commander-in-Chief at Portsmouth),

Who, with Lord Esher and Sir George Clarke, drew up the reorganisation scheme for the War Office.

The Admiral lately received the honour of a private visit from His Majesty the King, who inspected Portsmouth Dockyard, etc., and on board the *Alberta*, *en route* for Cowes, witnessed some special evolutions carried out by submarines and destroyers.

POWER STATION

NOTES AND NEWS.

The Power Station at Brattforsen.

The accompanying illustration shows a notable Swedish power station. This, says Affärsvärlden, has been extended so that it can now supply as much as 2,500 electrical h.p.

The material used for the Brattforsen dam is hewn granite, and it rests upon the solid rock; its pillars and front course are embedded in cement, and including the abutments, it has a total length of about 150 metres and an average height of 8·5 metres. On the north bank of the river, about 20 metres below the dam, the power-station has been built. The water is conducted to the spot by two tubes, with diameters respectively of 3 and 2 metres. The height of the fall of water is from 13 to 15 metres, varying with the backwater.

There is nothing to prevent the Orebro Electrical Company supplying considerable additional quantities of power, for arrangements have been made at Brattforsen for utilising the waterfall to the whole of its height, *e.g.*, 22 metres, by building an extension of the dam and carrying out canalisation, etc., to some extent. The principal part of the machinery is, moreover, arranged so as to facilitate the utilisation of the fall in its entire height.

The British Westinghouse Electric and Manufacturing Company, Ltd., announce that they are now in a position to receive visitors at their new office at Market Place Buildings, Sheffield, which has hitherto been used only for correspondence. This new branch office is in charge of Mr. C. A. Slater, and it is anticipated that it will prove a great convenience to clients.

Since January 1st, the business of the Electrical Transmission Company, Albert Works, Hammersmith, has been amalgamated with that of the Sturtevant Engineering Company, Ltd., whose works are at 29, Bankside, S.E.; offices, 147, Queen Victoria Street, E.C. By this step the very extensive range of all forms of motor starting and controlling devices manufactured by the Sturtevant Engineering Company Ltd., has been augmented by the addition of the specialities in switchgear manufactured by the Electrical Transmission Company.

The Bankside works will be devoted to the manufacture of all apparatus connected with the higher forms of motor control, such as is used for lifts, winches, hoists, haulage, cranes, pumps, etc., and every description of automatic controlling devices. The Hammersmith works will be devoted to the manufacture of the E.T.C. specialities, such as main switches, traction accessories, feeder and section pillars for power and lighting, service switches, motor starters, and speed regulators, etc. The whole field of motor control and switch work is thus covered by the standard apparatus of this combination.

The commercial management of both concerns will be directed from the head office of the Sturtevant Engineering Company, Ltd., at 147, Queen Victoria Street, E.C., to which all correspondence should be addressed.

The battleship *New Zealand*, launched at Portsmouth, sister ship to *King Edward VII.*, is the largest warship ever built at Portsmouth Dockyard.

AT BRATTFORSEN, SWEDEN.

Messrs. Graham Morton and Co., Ltd., of Leeds and London, have just secured contracts for the building of eleven bridges for the Great Western Railway Company and fifty-seven girder bridges for the Bengal North-Western Railway Company.

We understand that Messrs. Richardsons, Westgarth, and Co., Ltd., of Hartlepool Engine Works, have laid down a special plant for the manufacture of steam turbines under license from the Hon. C. A. Parsons.

Mr. A. E. Aspinall is leaving the service of the British Westinghouse Electric and Manufacturing Company, Ltd., for that of the De Beers Consolidated Mines, Ltd., Kimberley, and will act in the capacity of manager of the Costs Department.

A fine display of coal-cutting machinery and electrical plant, coal conveyors, rock drills, pumping machinery, etc., is promised at the second Colliery Exhibition, which will be held at the Royal Agricultural Hall from June 25th to July 2nd.

With the approval of the Council of the Sanitary Institute, Mr. Scott-Moncrieff's sewage-testing apparatus can now be seen in the Parkes Museum. The apparatus has been designed for the purpose of obtaining exact information upon which to base bacterial sewage disposal schemes, particularly as to (1) the depth of filter required to produce the necessary standard of purity in the effluent; (2) the quantity of air necessary for the life processes of the organisms in the filter; (3) the correct rate of flow per unit of filter-bed surface in order to obtain the best results; and (4) the best period of rest between each discharge to prevent galatinous growths in the filtering material.

Messrs. the Taff Vale Railway Company have placed an order with Messrs. the Bristol Wagon and Carriage Works Company, Ltd., of Bristol, and Messrs. the Avonside Engine Company, of Bristol, for six steam motor cars for passenger traffic to run on their railway. These are duplicates of the one designed by the Railway Company's Locomotive Superintendent, Mr. T. Hurry Riches, which has been working so successfully during the past few months. The Avonside Engine Company are building and supplying the locomotive portion to the Bristol Wagon and Carriage Works Company, who are making the carriage portion. The cars are to be delivered for the summer traffic.

At the invitation of the Main Drainage Committee of the London County Council, a number of ladies and gentlemen were present at the formal opening by Lord Monkswell, the Chairman of the Council, of the new pumping station just completed at Lots Road, Chelsea. Lord Monkswell mentioned that the pumping stations of the Council could now deal with over 600,000 gallons a minute. The total cost of the new station has been about £82,000, of which the buildings (erected by the Works Department) accounted for about £50,000, the pumps by Messrs. Easton and Co. for about £6,100, and the engines by Messrs. Crossley Brothers for about £10,300.

The eleventh annual conversazione of the Junior Engineering Society proved a most enjoyable function, an exhibition of mechanical appliances including Mr. Churchward's model of the G.W.R. valve gear, and a locomotive model built by Mr. M. R. Clarke. A two-cylinder, cross-compound, oil-fired locomotive model by Mr. J. C. Crebbin, together with that gentleman's four-cylinder tandem-compound locomotive model, came in for much investigation, and there were many other interesting features. The Society medal was presented to Mr. D. G. Slatter for his paper, "Instruction in Modern Gas-Holders."

A LARGE PELTON WHEEL IN USE NEAR PORT TALBOT.

Large Pelton Wheel Installation.

This illustration shows one of two large Pelton wheels installed by Messrs. Gilbert Gilkes and Co., Ltd., at the Tinplate Works of the Copper Miners' Tinplate Company, Ltd., Cwm Avon, near Port Talbot, South Wales. These wheels are employed for driving 19-in. rolls used for rolling out thin sheets.

Screw for 150-ton Sheer Legs.

We illustrate, by the courtesy of Messrs. W. Somers and Co., Ltd. of Halesowen, near Birmingham, an enormous screw, designed for 150-ton sheer legs which are being erected at Chatham Dockyard. The screw will be used for moving the back leg of the sheers. It weighs 17½ tons and was forged from a single ingot of steel. It is 85 ft. 7 in. long, and 11½ in. in diameter, and has a 2 in. thread.

17½-TON SCREW FOR SHEER LEGS

Forged by Messrs. W. Somers and Co., Ltd., of Halesowen, near Birmingham, from a single ingot.

SLIDE RULES
FOR THE
MACHINE SHOP.

BY

CARL G. BARTH.

The following account of slide rules for the machine shop, as part of the Taylor system of management, was given by the author to the American Society of Mechanical Engineers, at their New York meeting in December. The author has been engaged in making a series of experiments in order to establish data in regard to resistances in cutting steel with edged tools, consequent upon the introduction of high speed steel, and he describes the most interesting of slide rules used in connection therewith.—ED.

BY the use of the slide rules described in the following pages, a most complex mathematical problem may be solved in less than a minute. The author will confine his attention to slide rules for lathe, sand will take for an example an old-style belt-driven lathe with cone pulley and back gearing.

Considering the number of variables that enter into the problem of determining the most economical way in which to remove a required amount of stock from a piece of lathe work, they may be enumerated as follows :—

1. The size and shape of the tools to be used.
2. The use or not of a cooling agent on the tool.
3. The number of tools to be used at the same time.
4. The length of time the tools are required to stand up to the work (life of tool).
5. The hardness of the material to be turned (class number).
6. The diameter of this material or work.
7. The depth of the cut to be taken.
8. The feed to be used.
9. The cutting speed.
10. The cutting pressure on the tool.
11. The speed combination to be used to give at the same time the proper cutting speed and the pressure required to take the cut.
12. The stiffness of the work.

All of these variables, except the last one, are incorporated in the slide rule, which, when the work is stiff enough to permit of any cut being taken that is within both the pulling power of the lathe and the strength of the tool, may be manipulated by a person who has not the slightest practical judgment to bear on the matter ; but which as yet, whenever the work is not stiff enough to permit of this, does require to be handled by a person of a good deal of practical experience and judgment.

However, we expect some day to accumulate enough data in regard to the relations between the stiffness of the work and the cuts and speeds that will not produce detrimental chatter, to do without personal judgment in this matter also, and we will at present take no notice of the twelfth one of the above variables, but confine ourselves to a consideration of the first eleven only.

Of these eleven, all except the third and tenth enter into relations with each other that depend only on the cutting properties of the tools, while all except the

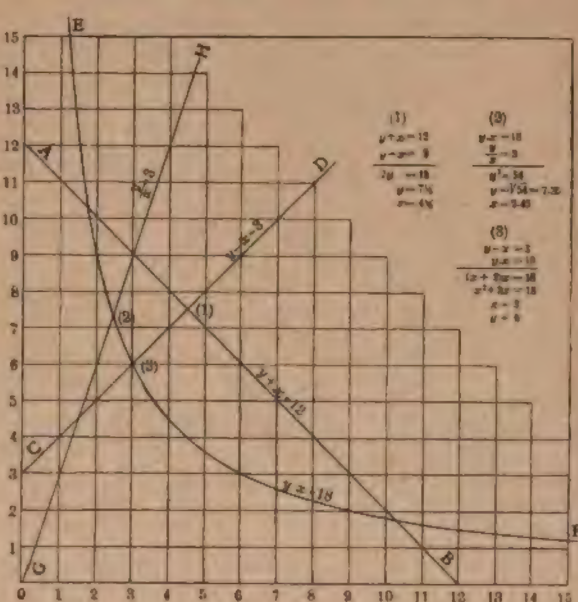


FIG. 1.

second, fourth, and ninth also enter into another set of relations that depends on the pulling power of the lathe, and the problem primarily solved by the slide rule is the determination of that speed combination which will at the same time most nearly utilise all the pulling power of the lathe on the one hand, and the full cutting efficiency of the tools used on the other hand, when in any particular case under consideration values have been assigned to all the other nine variables.

If our lathe were capable of making any number of revolutions per minute between certain limits, and the possible torque corresponding to this number of revolutions could be algebraically expressed in terms of such revolutions, then the problem might possibly be reduced to a solution, by ordinary algebraic methods, of two simultaneous equations containing two unknown quantities; but as yet no such driving mechanism has been invented, or is ever likely to be invented, so that, while the problem is always essentially the solution of two simultaneous equations, or sets of relations between a number of variables, its solution becomes necessarily a tentative one; or, in other words, one of trial and error, and involving an endless amount of labour, if attempted by ordinary mathematical methods; while it is a perfectly direct and remarkable simple one when performed on the slide rule.

FIG. 2.

THE SLIDE RULE FOR SIMPLE PROBLEMS.

The slide-rule method of solution may, however, also be employed for the solution of numerous similar problems that are capable of a direct and perfect algebraic solution; and it will, in fact, be best first to exhibit the same in connection with the simplest imaginable problem of this kind.

In the first place, the solution of two simultaneous equations may be graphically effected by representing each of them by a curve whose co-ordinates represent possible values of the two unknown quantities or variables, for then the co-ordinates of the point of intersection of these curves will represent values of the unknown quantities that satisfy both equations at the same time.

Example 1.—Thus, if we have $y + y = 12$ and $y - x = 3$, these equations are respectively represented by the two straight lines *AB* and *CD* in fig. 1; and as these intersect at a point (1) whose co-ordinates are $x = 4\frac{1}{2}$ and $y = 7\frac{1}{2}$, these values will satisfy both equations at the same time.

Example 2. Suppose, again, that we have $xy = 18$ and $\frac{y}{x} = 3$, and these equations are respectively represented by the equilateral hyperbola EF and the straight line *GH*; and the co-ordinates to the point of intersection of these (2) being respectively $x = 2.45$ and $y = 7.35$, these values will satisfy both equations at the same time.

Example 3. Similarly, if we have $y - x = 3$ and $y.x = 18$, these equations are respectively represented by the straight lines *CD* and the equilateral hyperbola *EF*; and the co-ordinates to the point of intersection of these (3) being $x = 3$ and $y = 6$, these values will satisfy both equations at the same time.

The slide rule method of effecting these solutions—to the consideration of which we will now pass—will readily be seen to be very similar in its essential nature to this graphical method, though quite different in form.

In fig. 2 is shown a slide rule by means of which may be solved any problem within the range of the rule of the general form: "*The sum and difference of two numbers being given, what are the numbers?*"

The rule is set for the solution of the case in which the sum of the numbers is 12 and their difference 3, so that we may write

$$y + x = 12 \text{ and } y - x = 3,$$

which are the same as the equations in Example 1 above.

In the rule the upper fixed scale represents possible values of the sum of the two numbers to be found, for which the example under consideration gives $y + x = 12$, opposite which number is therefore placed the arrow on the upper slide.

The scale on this slide represents possible values of the lesser of the two numbers (designated by x) and the double scale on the middle fixed portion of the rule represents possible values of the greater of the two numbers (designated by y); and these various scales are so laid out relatively to each other, and

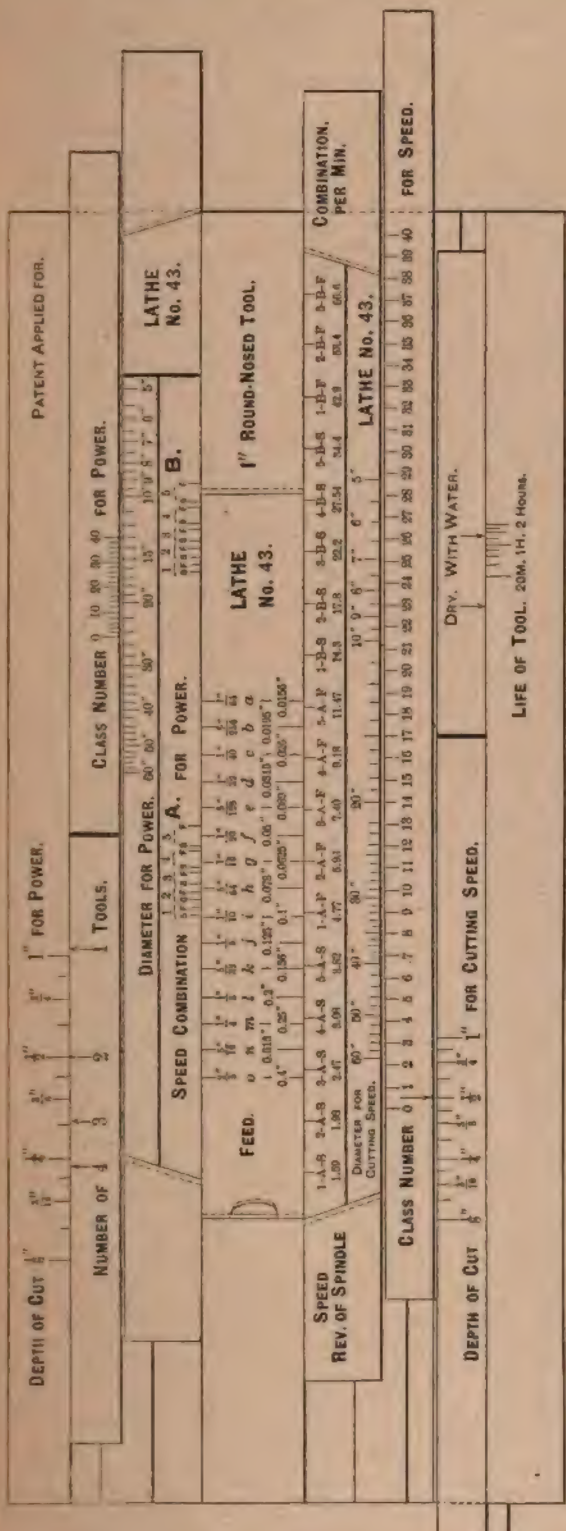


FIG. 3.

to the arrow referred to, that any two coincident numbers on these latter scales have for their sum the number to which this arrow is set; in this case accordingly 12.

The bottom fixed scale on the rule represents possible values of the difference of the two numbers, in this case 3, opposite which number is therefore placed the arrow on the bottom slide of the rule, the scale on which also represents possible values of the lesser of the two numbers, x; and the double fixed scale in the middle of the rule representing, as already pointed out, possible values of y, the whole is so laid out that any two coincident numbers on these latter scales have for their difference the number to which this arrow is set; in this case accordingly, 3.

Fixing now our attention on any number on the double y scale in the middle of the rule, we first note the values coincident to it in the two x scales on the slides; and, this done, we readily discover in which direction we must move along the first scale in order to pick out that value of y which has the same value of x coincident with it in both x scales. For the case under consideration this value of y is $7\frac{1}{2}$, and the coincident value in both scales is $4\frac{1}{2}$. Evidently, therefore, $y = 7\frac{1}{2}$ and $x = 4\frac{1}{2}$ are the numbers sought.

In the same manner we make a slide rule for the solution of the general problem: "*The product and quotient of two numbers being given, what are the numbers?*"

Such a rule would differ from the above described rule merely in having logarithmic scales instead of plain arithmetic scales.

By the combined use of both arithmetical and logarithmetic scales we may even construct rules for a similar solution of the general problems: "*The sum and product, or the sum and quotient, or the difference and product, or the difference and quotient, of two numbers being given, what are the numbers?*" and a multiplicity of others; and the writer ventures to suggest that slide rules of this kind, and some even simpler ones, might be made excellent use of in teaching the first elements of algebra, as they would offer splendid opportunities for illustrating the rules for the operations with negative numbers, which are such a stumbling block to the average young student.

We now have sufficient idea of the mathematical principles involved, for a complete understanding of the working of the slide rule whose representation forms the main purpose of this article.

AN IDEAL FORM OF SLIDE RULE.

This slide rule, in a somewhat ideal form in so far as it is made out for neither steel nor cast iron, but for an ideal metal of properties between these two, is illustrated in fig. 3. It will be seen to have two slides in its *upper section* and three in its *lower section*, and is in so far identical with the

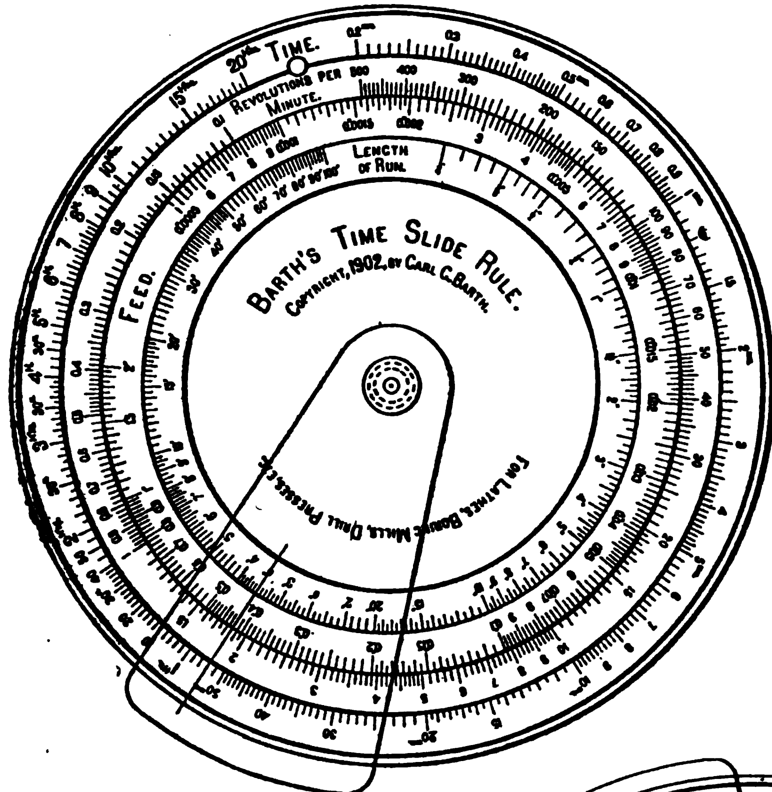


FIG. 4

rules made for the Bethlehem Steel Company, while in the rules more recently made it had been found possible and convenient to construct it with only two slides in the lower section also.

It is shown arranged for a belt-driven lathe (No. 43*) with five cone steps, which are designated respectively by the numbers 1, 2, 3, 4, 5, from the largest to the smallest on the machine. This lathe has a back gear only, and the back gear in use is designated by the letter *A*, the back gear out by the letter *B*. It also has two countershaft speeds, designated respectively by *S* and *F*, such that *S* stands for the slower, *F* for the faster of these speeds. The Speed Combination 3—*A*—*S* thus designates—to choose an example—the belt on the middle cone step, the back gear in, and the slow speed of the countershaft; and similarly, the combination 1—*B*—*F* designates the belt on the largest cone step on the machine, the back gear out, and the fast speed of the countershaft and so on.

The double, fixed scale in the middle of the rule (marked FEED) is equivalent to the *y* scale of the rule in fig. 2, and the scales nearest to this on the slides on each side of it (marked SPEED COMBINATION FOR POWER, and FOR SPEED, respectively) are equivalent to the *x* scales on the rule in fig. 2. The rest of the scales represent the various other variables that enter into the problem of determining the proper feed and speed combination to be used, fixed values being either directly given or assigned to these other variables, in any particular case under consideration.

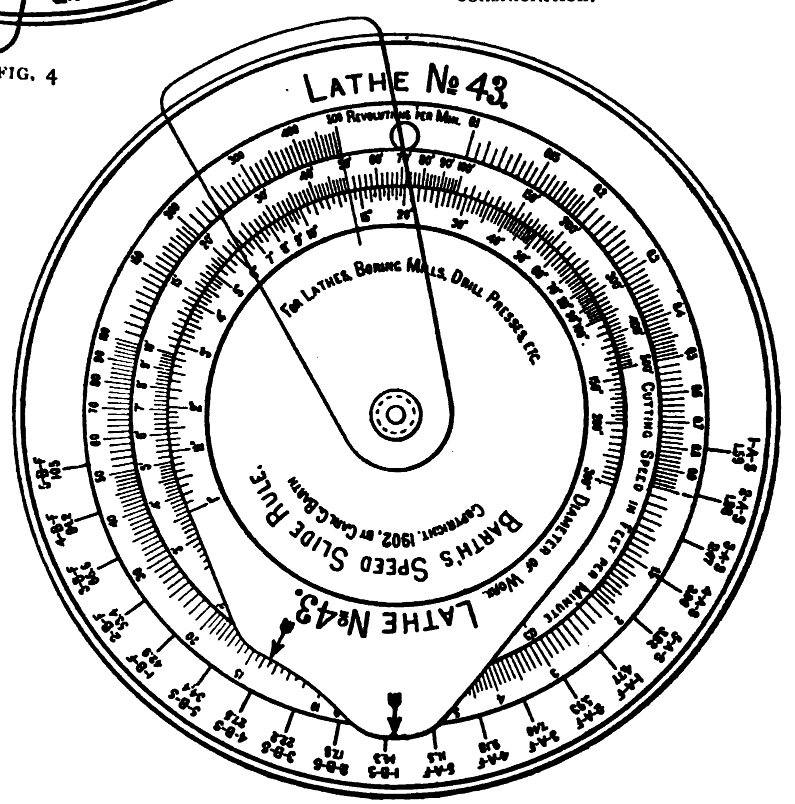


FIG. 5.

* The main frame of the rule is used for a number of lathes, and is arranged to receive interchangeable specific scales for any lathe wanted, as may be seen in the illustration.

The upper section of the rule embodies all the variables that enter into the question of available *cutting pressure* at the tool, while the lower section embodies all the variables that enter into the question of *cutting speed*: or, in other words, the upper section deals with the *pulling power* of the lathe, the lower section with the *cutting properties* of the tool; and our aim is primarily to utilise, in every case, both of these to the fullest extent possible.

SETTING RULE.

The example for which the rule has been set in the illustration is:

A $\frac{1}{2}$-*in.* depth of cut to be taken with each of two tools on a material of class 14 for hardness, and of 20 *in.* diameter, and the tools to last 1 *hour* and 45 *minutes* under a good stream of water.

The steps taken in setting the rule were:

1. The first scale in the upper or POWER section of the rule, from above, was first set so that 2 in the scale marked NUMBER OF TOOLS became coincident with $\frac{1}{2}$ *in.* in the fixed scale marked DEPTH OF CUT FOR POWER.

2. The second slide in this section of the rule was so set that 20 *in.* in the scale marked DIAMETER OF WORK FOR POWER became coincident with 14 in the scale marked CLASS NUMBER FOR POWER.

3. The first slide from below, in the lower or SPEED section of the rule was so set that the arrow marked WITH WATER became coincident with 1 *hour* 45 *minutes* in the fixed scale marked LIFE OF TOOL.

4. The arrow on the lower side of the second slide in this section of the rule was set to coincide with $\frac{1}{2}$ *in.* in the scale marked DEPTH OF CUT FOR CUTTING SPEED.

5. The third and last slide in this section was so set that 20 *in.* in the scale marked DIAMETER OF WORK FOR CUTTING SPEED became coincident with 14 in the scale marked CLASS NUMBER FOR CUTTING SPEED.

Let us now separately direct our attention to each of the two sections of the rule.

POWER SECTION.

In the POWER section we find that all the speed combinations marked *B* (back gear out), entirely beyond the scale of feeds, which means that the estimated effective pull of the cone belt reduced down to the diameter of the work, does not represent enough available cutting pressure at each of the tools to enable a depth of cut of $\frac{1}{2}$ in. to be taken with even the finest feed of the lathe. Turning, however, to the speed combinations marked *A* (back gear in), we find that with the least powerful of them (5—*A*—*F*) the *e* feed, which amounts to $\frac{1}{25 \cdot 4}$ inch — 0·039 in., may be taken; while the *f* feed, which amounts to $\frac{1}{20}$ in. = 0·05 in., is a little too much for it, though it is within the power of the next combination (5—*A*—*S*), and so on until we finally find that the most powerful combination (1—*A*—*S*) is nearly capable of pulling the *i* feed, which amounts to $\frac{1}{10}$ in. = 0·1 in.

SPEED SECTION.

In the SPEED section of the rule we likewise find that all the *B* combinations lie beyond the scale of feeds, while we find that the combination 5—*A*—*F* (which corresponds to a spindle speed of 11·47 revolutions per minute), can be used in connection with the finest feed (*a*) only, if we are to live up to the requirements set for the life of the tool; while the next combination (4—*A*—*F*) will allow of the *e* feed being taken, the combination 3—*A*—*F* of the *f* feed, and so on until we finally find that the combination 3*A* is but a little too fast for the coarsest (*o*) feed, and that both of the slowest combinations (1—*A*—*S* and 2—*A* is —*S*) would permit of even coarser feeds being taken, so far as only the lasting qualities of the tools are concerned.

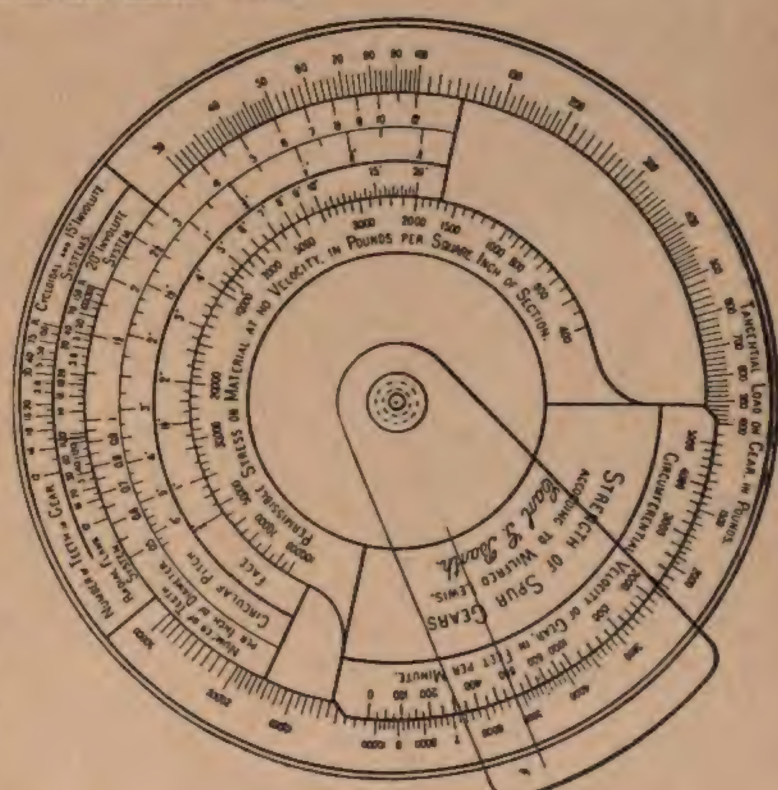


FIG. 6.

We thus see that there is a vast difference between what the POWER section of the rule gives as possible combinations of feeds and speeds for the utilisation of the full pulling power of the lathe, and what the SPEED sections of the rule gives for such combinations for the utilisation of the tools up to the full limit set. However, by again running down the scale of feeds we find that, in both sections of the rule, the *i* feed ($\frac{1}{10}$ in. = 0·1 in.), is but a trifle too coarse for the combination 1—*A*—*F*, while the *h* feed ($\frac{5}{64}$ in. = 0·078 in.) is somewhat too fine in connection with this speed combination 1—*A*—*F*, both for the full utilisation of the pulling power of the belt on the one hand, and for the full utilisation of the cutting efficiency of the tools on the other hand.

In this case, accordingly, the rule does not leave a shadow of doubt as to which speed combination should be used, while it leaves us to choose between two feeds, the finer of which does not allow us to work up to the full limit of either the belt or the tools, and the coarser of which will both overload the belt a trifle and ruin the tools a trifle sooner than we first intended to have them give out.

The final choice becomes a question of judgment on the part of the *Slide Rule and Instruction Card Man*, and will depend upon how sure he is of having assigned the correct CLASS NUMBER to the material or not; and this latter consideration opens up a number of questions in regard to the practical utilisation of the rule, which for the lack of time cannot be taken up in the body of this article.

THE TIME SLIDE RULE.

Having decided upon the speed and feed to use, the Instruction Card Man now turns to the TIME slide rule illustrated in fig. 4, and by means of this determines the time it will take the tools to traverse the work to the extent wanted, and making a fair allowance for the additional time consumed in setting the tools and calipering the work, he puts this down on the instruction card as the time the operation should take.

For finishing work the pulling power cuts no figure, so that this resolves itself into a question of feed and speed only; and for the selection of the speed combination that on any particular lathe will give the nearest to a desired cutting speed, the SPEED slide rule illustrated in fig. 5 is used.

It will readily be realised that a great deal of preliminary work has to be done before a lathe or other machine tool can be successfully put on a slide rule of the kind described above. The feeds and speeds and pulling power must be studied and tabulated for handy reference, and the driving belts must not be allowed to fall below a certain tension, and must in every way, be kept in first-class condition.

In some cases it also becomes necessary to limit the work to be done, not by the pull that the belts can be counted on to exert, but by the strength of the gears, and in order to quickly figure this matter over the writer also designed the GEAR slide rule illustrated in fig. 6, which is an incorporation of the formula established several years ago by Mr. Wilfred Lewis.

For the pulling power of a belt at different speeds, the writer has established new formulæ, which take account of the increasing sum of the tensions in the two sides of a belt with increasing effective pull, and which at the same time are based on the tensions recommended by Mr. Taylor in his paper entitled "Notes on Belting." These formulæ have also been incorporated on a slide rule.

CONCLUSIONS.

Having thus given an outline of the use of the slide rule system of predetermining the feeds and speeds, etc., at which a machine tool ought to be run to do a piece of work in the shortest possible time, the writer, who has made this matter an almost exclusive study during the last four years, and who is at present engaged in introducing the Instruction Card and Functional Foremanship System into two well-known Philadelphia machine shops, which do a great variety of work in both steel and cast iron, will merely add that, in view of the results he has already obtained, in connection with the results obtained at Bethlehem, the usual way of running a machine shop appears little less than absurd.

Thus already during the first three weeks of the application of the slide rules to two lathes, the one a 27 in. the other a 24-in., in the larger of these shops, the output of these was increased to such an extent that they quite unexpectedly ran out of work on two different occasions, the consequence being that the superintendent, who had previously worried a good deal about how to get the great amount of work on hand for these lathes out of the way, suddenly found himself confronted with a real difficulty in keeping them supplied with work. But while the truth of this statement may appear quite incredible to a great many persons, to the writer himself, familiar and impressed as he has become with the great intricacy involved in the problem of determining the most economical way of running a machine tool, the application of a rigid mathematical solution to this problem as against the leaving it to the so-called practical judgment and experience of the operator, cannot otherwise result than in the exposure of the perfect folly of the latter method.

The Grant and Validity of Patents.

A NEW WORK OF REFERENCE FOR LAWYERS AND PATENTEES.

MR. JAMES ROBERTS, M.A., LL.B., in the course of a new work on "The Grant and Validity of British Patents for Inventions,"* draws attention to a remarkable fact. It has been ascertained by an official enquiry that of the patents for inventions granted in England, no fewer than forty-two per cent., that is about 5,780 per annum, are invalid on the ground of having been already patented in this country. An examination of the results of litigation shows, that of such patents as are commercially worth infringing, no less than fifty-one per cent. are invalid. The invalidity of these patents is, in many cases, not discovered till after a lapse of years, but even assuming that no invalid patent is renewed, sums amounting to £23,120 per annum are paid for patents which give no legal protection to the patentees. This state of affairs, says Mr. Roberts, brings discredit upon all British patents and diminishes the market value even of those which are valid. Under these circumstances we imagine that a work which has been undertaken to enable the inventor to draw up his specification with the best possible chances of passing successfully between the Scylla of the patent office and the Charybdis of anticipated claims, should be welcome to all manufacturers who are concerned in placing new machinery on the market.

The first part consists of the principles and rules affecting the grant and validity of patents, and the practice respecting the amendment of specifications, both before the Comptroller-General and Law Officers of the Crown; the second, of abstracts of cases illustrating the applications of the principles; and the third of the statutes and rules.

In dealing with the question of the grant and validity of patents for inventions from the point of view of the inventor, it must be borne in mind, says the author, that, according to the English law and practice, the question of validity (save in a few cases) cannot be entertained or decided by the authorities whose duty it is to grant such patents. The inventor takes his patent at his own risk, and the validity of the grant may be contested in subsequent proceedings in the High Court, either by a petition for revocation being presented, or by the defence in an action for infringement. A "patentable invention" and a "valid claim" mean, therefore, not merely those for which a grant may be obtained, but those which will be upheld and supported in subsequent litigation.

The rules on which the questions affecting the grant and validity of patents depend are derived from various sources: (1) The common law and considerations of public policy; (2) the Statute of Monopolies, 1624; (3) a long series of decisions elucidating the foregoing; (4) the Patents, etc., Acts, 1883 to 1902, and cases thereon; and (5) the rules made under the provisions of those Acts. Although the rules relating to validity are mainly found in actions for infringement and petitions for revocation of patents, yet a knowledge of them is necessary in order to avoid taking out a patent which cannot be subsequently maintained when challenged.

Under the new practice introduced by the Act of 1902, the applicant will be informed by the Comptroller of such previous specifications as appear to anticipate the invention in respect of which a patent is applied for. He must, therefore, with professional assistance in most cases, decide whether he will modify his application, and if so, in what manner. This decision cannot be arrived at without a knowledge of the principles upon which the Courts decide on the validity of patents, and the mode of application of those principles.

The rules and their application are dealt with in the new work under *four* main heads or divisions:—

(1) The consideration of the "manufacture" or "invention" for which a patent may be granted, distinguishing it on the one hand from the principle, involved, the application of which constitutes the "invention," and on the other from the resulting advantages and uses to which it may be put; that is to say, where the monopoly begins and ends in relation to the *manufacture*.

(2) The relations arising from the development of the knowledge of the art in question, and the consideration of the "invention" of the manufacture in regard to *time*. On the one hand, there are the questions of novelty, prior user, prior grant to a rival inventor, and the question of the extent to which the proposed grant might interfere with workmen at the time by reason of the slight amount of ingenuity required to produce the invention in question. On the other hand, there is the relation of the patentee to *subsequent* inventors involving the question of how far the inventor can anticipate subsequent inven tors, by including that which he had not actually devised at the date of his application.

(3) The persons to whom and the conditions on which the grant will be made. Under this head come the filing of specifications disclosing the method of performing the invention and making distinct claim or claims thereto, and also questions arising from the policy of the law and the rules of construction or interpretation of specifications.

(4) The procedure to be followed, the drafting of specifications, the amendment of specifications, and opposition to the final sealing of the patent.

* "The Grant and Validity of British Patents for Inventions." By James Roberts, M.A., LL.B. John Murray. 25s. net.

MODERN STEEL MANUFACTURE.

A COMPARISON OF THE BESSEMER AND OPEN-HEARTH PROCESSES.

SOME of the most interesting pages in Professor F. W. Harbord's new work on "The Metallurgy of Steel,"* are devoted to a comparison of the Bessemer and open-hearth processes.

The first consideration is the question of quality, and here, says Professor Harbord, it must be admitted that acid processes have the advantage over basic processes working under ordinary conditions, as, assuming care is taken to select suitable pig-iron, the risk of producing high phosphorus steel in the acid processes is at once eliminated, whereas, however great the care taken, the removal of the phosphorus in the basic processes depends upon the skill and attention of the men, and there is always the possibility that the metal may not be dephosphorised to the required extent. In the case, too, of the manufacturer of rails, or other fairly high carbon steel in the converter, there is the additional risk of rephosphorisation from the slag on adding the recarburising material, even when every precaution is taken. With dead soft steel this danger exists in a smaller degree. In respect to removal of other impurities, the acid processes offer no advantages over the basic, as, in the removal of sulphur, the advantage lies with the basic process, in which removal, if somewhat erratic, does frequently take place.

With regard to the open-hearth process where steels of different grades are required, with carbon varying from ·100 to ·70 or 1·00, the acid process has again the undoubted advantage over the basic open hearth, as in working ordinary phosphoric pig-iron, recarburisation would have to be effected outside the furnace by some recarburising process, which does not enable the same control to be maintained as when it can be done in the hearth of the furnace. In the special case of working hematite iron in a basic furnace, the conditions are different, and we have the advantage of the pure iron used in acid furnaces, with the additional advantage that even the small percentages of phosphorus originally present would be greatly reduced, and, consequently, an exceptionally pure material can be made.

Comparing the quality produced in the open hearth, whether acid or basic, with that of the Bessemer processes, there can be no doubt that the former produces a more regular and reliable material. In the first place, the operations are under greater control. Samples can be taken at repeated intervals, and examined if necessary, both chemically and mechanically, and the working of the process modified to produce the desired result. There is also far less danger of over-oxidation. That the quality of open-hearth steel is, for the same class, superior to Bessemer, is confirmed by the fact that engineers, as the result of experience, always prefer it, and are prepared to pay a higher price for it. For high carbon steels which have to conform to rigid specifications, the acid Siemens is almost exclusively employed, as experience has shown that it is extremely difficult to get the exact carbon percentage specified by the other processes. Exception to this may be made in a few cases of small Bessemer plants in Sweden and this country, working under special conditions as to the regularity and quality of their pig supply, and the smallness of their charges; but, speaking generally, the statement is correct.

Yield of Metal.

Here the open-hearth processes have a considerable advantage over the Bessemer. The average yield of an acid Bessemer plant making rail steel will vary from about 86 to 88 tons of steel ingots for every 100 tons of metal (including pig, scrap, spiegel, etc.) used; and a basic Bessemer will yield only about 83 tons of ingots, whereas the acid open hearth will yield about 97 and the basic about 95·0 tons of ingot per 100 tons of metal charged into the furnace. One reason why the yield in the basic processes is lower than the acid, is that the chemical loss due to presence of phosphorus and more manganese is greater.

Cost of the Acid and Basic Processes.

Both the labour costs and the costs as regards renewals of linings, repairs and general refractories must always be higher in the basic than in the acid processes; but against these disadvantages must be put the lower cost of pig-iron and scrap and the value of the basic slag produced. For the same size of plant, on the other hand, the output of the acid processes will be greater.

Comparison as to Cost.

Under this heading it is shown that the difference in cost of production by the acid and basic Bessemer is so little, that it is almost impossible to say which has the advantage, although it is probable that the basic is slightly the cheaper.

The acid Siemens costs of production are probably a little higher than any of the others, although they are only slightly so, and, provided a good supply of scrap equal to 30 per cent. of the charges can be obtained, the difference is very slight.

Future for Basic Open-hearth Steel.

"It seems probable," says the author, "that in the future the basic open hearth, or some modification of it, will gradually supersede both the basic and acid Bessemer, and to some extent the acid open hearth, both for structural and rail steel, as there are immense deposits of ores which are just too phosphoric for acid work, and which would make an ideal pig-iron for basic open-hearth practice. From many of these ores a pig-iron with about ·15 to ·5 per cent. of phosphorus would be produced, and such a pig-iron worked under basic open-hearth conditions would undoubtedly produce a far better material than is on the average produced either by the acid or basic Bessemer, as with such content of phosphorus in the pig-iron the risk of making steel high in phosphorus would be practically nil, or at all events not so great as the risks incurred by using hematite iron dangerously near the limit allowed in acid open-hearth practice.

* "The Metallurgy of Steel," by F. W. Harbord, Assoc.R.S.M., F.I.C., with a Section on the Mechanical Treatment of Steel, by J. W. Hall, A.M.Inst.C.E. Charles Griffin & Co., Ltd. 25s. net.

SHIPBUILDING NOTES.

Differing Returns.

Since our estimate was made for publication in last number of the output of new ships in 1903 the statistics of Lloyd's Register have appeared. These, as usual, differ to some extent from the shipbuilders' returns upon which we proceed, because Lloyd's do not include vessels under 100 tons unless they are intended for classification, and they account vessels "under construction" so long as they are in builders' hands, whereas we enumerate only the vessels put into the water during the period under review. It is necessary to remember this, and also the manner in which warships and merchant ships are accounted separately, in noting Lloyd's returns. According to these, during 1903, 697 vessels, exclusive of warships, of 1,190,618 tons gross (viz., 632 steamers of 1,165,503 tons and 65 sailing vessels of 25,115 tons) were launched in the United Kingdom. The warships launched at both Government and private yards amounted to 41 of 151,890 tons displacement. The total output of the United Kingdom for the year was, therefore, 738 vessels of 1,342,508 tons. The output of mercantile tonnage in the United Kingdom during 1903 shows a decrease of 237,000 tons from 1902, and is the lowest since 1897. Compared with the returns for 1901, when the output of both mercantile and war tonnage reached the highest level, the figures show a reduction of 334,000 tons as regards merchant vessels, and 60,000 tons as regards war vessels.

British Output.

Of the total output, 936,776 steam tons and 13,800 sailing tons, or 950,576 tons in all (80 per cent.) belong to ports in the United Kingdom. The losses of United Kingdom vessels during the twelve months are shown by the Register Wreck Returns to average 258,200 tons (202,700 steam, 55,500 sail). The sales to foreign and colonial owners for 1903 reached a total of 352,000 tons (294,000 steam, 58,000 sail). Purchases from foreign and colonial owners during the same period amounted to 65,000 tons (57,000 steam, 8,000 sail). The sailing tonnage of the United Kingdom thus decreased by about 92,000 tons, while the steam tonnage increased by 497,000 tons. The net increase of United Kingdom tonnage during 1903 was, therefore, about 405,000 tons. For the last four years the estimated net increases were as follows:—1899, 313,000 tons; 1900, 220,000 tons; 1901, 543,000 tons; 1902, 643,000 tons. In 1903, 18 per cent. of the total output was acquired by foreign and colonial shipowners, as compared with 18 per cent. in 1902, 23 per cent. in both 1901 and 1900, 19 per cent. in 1899, 22 per cent. in 1898, and 25 per cent. in 1897. The British Colonies provided a considerable amount of employment for the shipbuilders of the United Kingdom, viz., 30 vessels of 33,793 tons (2·8 per cent. of the total output). Germany followed with nine vessels of 26,598 tons. Next Norway with 25,813 tons, and Holland with 18,153 tons.

Large Steamers.

The shipbuilding statistics of recent years have illustrated the tendency towards the construction of steamers of large tonnage. During the four years, 1892-5, on an average eight vessels of 6,000 tons and upwards were launched per annum in the United Kingdom; and in the following four years, 1896-9, the average rose to 25. For the last four years, 1900-3, the average has been 39. Of vessels of 10,000 tons and upwards, while only three were launched in the four years, 1892-5, 17 were launched during the four years 1896-9; and 32 have been launched during the four years 1900-3. The largest steamers launched during 1903 were the following:—

	Tons gross.		Tons gross.
Baltic	23,763	Kenilworth Castle	13,150
Not named... ...	16,780	Armadale Castle...	12,800
Not named... ...	16,780	Macedonia ...	10,523
Republic	15,378	Marmora	10,523

The largest sailing vessel launched in the United Kingdom during 1903 was the *Mneme* of 2,456 tons.

Turbine Steamers.

In view of the increasing employment of the turbine method of propulsion we may note the names of the steamers fitted with turbines launched during 1903. They are as follows:—

	Tons displacement.		Tons gross
H.M.S. Amethyst...	300	Yacht Lorena ...	1,303
H.M.S. Eden ...	565	Channel Steamers—	
		The Queen ..	1,676
		Brighton... ...	1,129

Foreign Output.

The construction in foreign shipyards during the year, according to Lloyd's, was 549 steamers of 798,205 tons, and 404 sailing vessels of 156,808 tons, in addition to 78 war vessels of 239,210 tons displacement. Among foreign countries, the largest builders were the United States of America (382,000 tons), Germany (184,000 tons), and France (93,000 tons). Of the mercantile tonnage reported from the United States, a considerable proportion does not affect the general commerce of the world, being intended for service on the Great Lakes. Twenty-four steamers were built for this trade during 1903 of upwards of 4,000 tons each, while seven others ranged between 3,000 and 4,000 tons each. On the sea coast, nine steamers of over 4,000 tons each, besides six steel and three wooden sailing vessels of over 2,000 tons each, were launched. The largest steamers included in these figures are the following:—

	Tons gross.		Tons gross.
Minnesota ...	21,000	Maine	7,914
Mongolia ...	13,638	Missouri ...	7,914
Manchuria ...	13,638		

Germany launched one steamer exceeding 8,000 tons, viz., the *Gneisenau*, of 8,081 tons, built at Stettin, and 13 steamers between 4,000 and 8,000 tons. The only important sailing vessels included in the output of Germany during the year was the four-masted barque *Petschili* of 3,087 tons, built at Hamburg, under the survey of Lloyd's Register. The most significant feature in respect of the shipbuilding industry in France during 1903 was the abandonment of the construction of large sailing vessels. During the years 1899 to 1902 the numbers of steel sailing vessels of 2,000 tons and upwards launched in France were, respectively, 24, 38, 49, and 54. During 1903 not one such vessel was launched. The steam tonnage launched in France during 1903 amounts to 83,000 tons, or 38,000 tons in excess of the output of 1902.

The World's Output.

The total output of the world during 1903 (exclusive of warships) appears from Lloyd's figures to have been about 2,146,000 tons (1,964,000 steam, 182,000 sail). The Wreck Returns show that the tonnage of all nationalities totally lost, broken up, &c., in the course of the twelve months amounts to about 744,000 tons (419,000 steam, 325,000 sail). The net increase of the world's

mercantile tonnage during 1903 would thus be about 1,402,000 tons. Sailing tonnage has been reduced by 143,000 tons, while steam tonnage has increased by 1,545,000 tons. Compared with the net increase for the world the net increase of 405,000 tons for the United Kingdom is equivalent to nearly 29 per cent. In the net increase of the world's steam tonnage, viz., 1,545,000 tons, the United Kingdom shared to the extent of 497,000 tons, or over 32 per cent. Of the tonnage launched during 1903, the United Kingdom acquired over 44 per cent; and of the new steam tonnage the United Kingdom acquired nearly 48 per cent.

Comparative Totals.

We extract the following from Lloyd's summary in order to compare with the statistics we presented last month :—

Vessels launched in the United Kingdom during 1903 :—

	Total 1903.		Total 1902.	
	No.	Tons.	No.	Tons.
Merchant and other vessels (not warships)	697	1,190,618*	694	1,427,558*
Warships at Royal Dockyards† ...	4	28,290†	5	51,400†
Warships at private yards	37	123,600	18	42,740
Total ...	738	1,342,508	717	1,521,698

* Tons gross. † Tons displacement.

Allan Turbine Steamers.

With regard to the two new turbine boats which the Allan Company are building, the first of them, the *Victorian*, is to be ready for work in the summer of this year. The turbine machines to Mr. Parsons' designs are being constructed by Messrs. Workman, Clark and Co., Ltd., Belfast, who have secured the right of constructing such engines. The workmanship will be of the highest class, the boiler power ample, and the pumps, valves, condensers, and other allied parts are specially adapted to the designs of Mr. Parsons. A special arrangement has been devised by Mr. Parsons, whereby a reversing power equal to that of the forward propelling power can be imparted to the machinery, securing almost instant arrestment of the ship's forward motion, and speedy backing in case of need. In this matter the *Victorian* is designed to surpass the ordinary steamer. The widespread arrangement of her propellers, of which there are three in number, each on a separate length of shafting, and the rapidity with which power can be directed upon each of the outer shafts separately, in any direction, will greatly assist the ship's manœuvring power. The *Victorian* will be by far the largest steamer and swiftest of the Allan fleet. She will be fitted in the best style for upwards of 1,500 passengers, and is expected, by reason of the absence of vibration inseparable from the ordinary steam engine, and by the rapidity and unbroken steadiness of revolution in her shafting and propellers, to be both noiseless and steady in a seaway, even while steaming at full power. She is expected to save a day in the voyage between Liverpool and Montreal.

Transatlantic Passenger Traffic.

The return of passengers landed by Transatlantic liners at New York during 1903 shows an increase of about 90,000 of all classes, equal to 12½ per cent., while the number of ship passages is only 4·7 per cent greater. The British lines seem to have done better than the German, the addition to their numbers being 16½ per cent., against 13½ per cent. by the German vessels; but in cabin passengers the German ships excelled, their increase being about 25 per cent., against about 12½ per cent. for British lines. The German ships carried 37·3 per cent. of all the cabin passengers, as compared with 34 per cent. in the previous year, while the proportion by British ships declined from 37¼ per cent. to 34·3 per cent. This is attributed to the high-speed vessels of the Germans. The mails per *Kaiser Wilhelm der Grosse* averaged 152 hours 18 minutes; the *Kronprinz Wilhelm*, 154 hours 18 minutes; the *Kaiser Wilhelm II.*, a third North-German Lloyd liner, 161 hours 6 minutes; and the *Deutschland*, 162 hours 42 minutes, all from New York to St. Martin's-le-Grand. The fifth ship was the the *Lucania*, with 170 hours 36 minutes; next, the *Campania*, 171 hours 18 minutes; the *Oceanic*, 173 hours 6 minutes; the *Philadelphia*, 178 hours 54 minutes; *La Savoie*, 180 hours 12 minutes, and *La Lorraine*, 180 hours 18 minutes. The ships of the Morgan Combine, other than the German liners, decreased their proportion of cabin passengers from 31 per cent. to 28 per cent.—their percentage of steerage passengers remaining practically the same, 18·3 per cent.

Classes of Passengers.

The total number of passengers was 804,795, about double the number landed in 1899, and nearly three times the number of 1894 and 1897, but the number of ships has not increased greatly. Cabin passengers show a greater proportionate advance in numbers than steerage passengers. Thus there were 161,438 cabin passengers in 1903, or 15 per cent. more than in 1902, and nearly double the average of 1894-98. Second-cabin passengers bear a proportion to first-class of 1·38 to 1, the totals being 67,808 first and 93,630 second-class passengers. The steerage passengers numbered 643,358, about 12 per cent. more than in 1902, and the greatest yet recorded. The number of trips last year was 969—the largest number for many years—and the average number of passengers was the highest yet reached, viz., 830, as compared with 773 in 1902, while in 1901 it was 639, and in 1900, 643. Since 1897 it has steadily increased from 313. All the Continental lines increased their totals, and several of these, especially the large emigrant-carrying lines, had a very large average per ship. The total passengers in the case of the Holland-American lines work out to a fraction over 1,000, principally in the steerage, the Italian line about 900, the Prince line 874, the Fabre line 816, and the Spanish line 505.

Cunard and White Star.

The White Star line has the best record for average first-class passengers per ship, and for first and second-cabin average the Cunard yields to the North German Lloyd. The Cunard Company made more trips than in several preceding years, viz., 65, against 51, 57, 51 and 62; and there was thus a reduction in the number of cabin passengers per ship from 320 to 284 in 1902, but an increase in the number in the steerage from 464 to 518. The Cunard had one trip from the Mediterranean—a new service which took 74 second cabin and 241 steerage passengers. The White Star increased the number of passages made, 91 as compared with 65, 66, 50, and 57. The cabin passengers per trip averaged last year 246, while in 1902 the number was 283, in 1901 275, in 1900 299, and in 1899 223. The average number of steerage passengers was 502 in 1903, while in the previous years it was 619, 462, 587, and 442 respectively.

LOCOMOTIVE ENGINEERING NOTES.

BY

CHARLES ROUS-MARTEN.

A Huge American Locomotive.

America seems determined to keep well in front as regards locomotive magnitude. We, in Great Britain, have gradually and cautiously crept up to a total weight of 73 tons for an express tender engine, exclusive of its tender, as in the case of the newest express engine of the Caledonian and North-Eastern Railways, while the former has a total weight (including her eight-wheel tender) of approximately 130 tons, a new tank engine to which later reference will be made and which has just been constructed for the Lancashire and Yorkshire line, weighs 77½ tons in working order. All of these represent a vast advance on what a comparatively few years ago was deemed an enormous and barely justifiable weight on the rails. Twenty and even fifteen years ago, a tender-engine weighing 50 tons, exclusive of its tender, was something quite unknown in this country. Even ten years ago very few British tender-engines reached, and fewer exceeded, that weight. It was little more than four years ago that Mr. J. A. F. Aspinall brought out what then was regarded as a wonder of bigness, his express engine No. 1400 of the "Atlantic" or 4–4–2– class, which weighed 58½ tons. Later Mr. Wilson Worsdell beat that with 62 and 67 tons respectively; then Mr. W. Dean followed with 69 tons, and now Mr. G. J. Churchward has exceeded 70, while Mr. J. F. M'Intosh's No. 49 of the 4–6–0 type on the Caledonian, and Mr. Worsdell's 4–4–2–, No. 532, etc., on the North-Eastern, are accredited with a weight of 73 tons each, if indeed this be not somewhat exceeded in the case of the Caledonian colossus. And, lastly, we have, as I have said, a Lancashire and Yorkshire tank engine weighing 77½ tons, but that is, of course, engine and tender in one. Yet these enormous dimensions which staggered us at their onset sink into relative insignificance when compared with those of an American locomotive recently brought out by Messrs. Burnham, Williams and Co., at their celebrated Baldwin Works, Philadelphia, U.S.

A Mighty Tandem Compound Decapod.

When one has used up such picturesque terms as "giant," "colossus," "leviathan," "monster," etc., in depicting our British engines, one is simply unable to devise any descriptive term which will be adequate to indicate the new locomotive. For, in the first place, the engine itself in working order weighs over 127 tons, exclusive of the tender; the tender weighs approximately, 73 tons loaded, so that the total weight of engine and tender at work reaches the almost incredible aggregate of 200 tons, carried on no fewer than twenty-two wheels. I may explain that it has been specially designed and built for heavy goods traffic on the Atcheson, Topeka, and Santa Fé Railway, where the loads are heavy and the gradients severe. The engine may be classed as of the Decapod type, the term being used in its common-sense purport indicating that the machine walks upon ten "feet"; in other words, has ten wheels coupled. The fact of its having a two-wheel pony truck in the rear as well as in front, does not in reality modify its decapod character. Or according to the most recent system of classification, its type is 2–10–2. The coupled wheels are 4 ft. 9 in. in diameter, and the middle pair is driven by four outside cylinders arranged in pairs tandemwise, the two high-pressure cylinders placed in front being 19 in. in diameter, the two low-pressure cylinders immediately behind them 32 in., while the piston stroke is also 32 in. These ten-coupled wheels have an adhesion weight of over 104 tons. It will thus be obvious that the engine possesses gigantic tractive force, but this stupendous cylinder power would be of little value unless supported by abundant boiler capacity for steam generation. Accordingly, an extended wagon top boiler is supplied, which is no less than 6 ft. 6⅜ in. in diameter with a length of 20 ft. between the tube-plates. It has a total heating surface of 4,796 square feet, of which the iron tubes—2¼ in. in diameter—provide 4,586 square feet, and the steel fire-box, which is 9 ft. by 6 ft. 8 in., 210 square feet, the grate area being 58½ square feet. Moreover, it carries the immense steam pressure of 225 lb. to the square inch. Now the mere recital of these amazing dimensions is sufficient to show at a glance to any professional reader what a powerful machine is represented. It will be most interesting to learn of what maximum duty such an engine is capable. In this small country one finds it difficult to realise the length of the goods-trains that can profitably be hauled on such a line as the Santa Fé, which, by-the-by, gives its title, or rather nickname, to the new engine. In Britain there would be no scope for a locomotive so vast; the load of American dimensions is needed to afford full play to its capabilities.

The Tandem Plan of Compounding.

So far, locomotive engineers all over the world have seemed a little shy of adopting the tandem system of compounding. It was tried on our own Great Western Railway some fourteen or fifteen years ago, two 7 ft. coupled express engines being built on that principle, but for various reasons of detail, into which I need not now enter, the plan did not prove a success, and was accordingly abandoned. Another method of tandem compounding was tried on the North British Railway, being applied to the identical engine that was in the Tay Bridge accident and that had lain for many months at the bottom of the Tay estuary. It is not probable that the long submersion had anything to do with the result of the experiment, but, at all events, the outcome did not give satisfaction, and the engine, No. 224, was rebuilt on the ordinary non-compound lines. The tandem plan has been tried several times on Continental railways, and, indeed, is still in use to a limited extent, but has never hitherto come into very wide favour. One of its most recent and interesting applications abroad has been in the case of some new suburban tank engines designed by Monsieur du Bousquet, Ingénieur-en-Chef du Matériel et de la Traction of the Chemin de Fer du Nord, which have been at work for some months, and, apparently, are giving favourable results. In the case of the new Santa Fé engine the two low-pressure cylinders and their valve chests are supported by a suitable casting secured to the smoke-box, while the high-pressure cylinders with their steam chests are secured to the fronts of the low-pressure cylinders. The valves are of the balanced-piston type with bushings forming the interior of the chests. Connections between the steam chests and the respective high and low-pressure valves are in the form of a slip joint, made tight with a packed gland. The valve is made in two sections, one governing the admission of steam to the high-pressure and the other that to the low-pressure cylinder, but both sections are secured and operated by the same rod. To enable

the steam to pass from the front of the high-pressure cylinder to the back of the low-pressure cylinder, and *vice versa* without crossed ports, the steam is exhausted from the high-pressure cylinder by means of the central opening in the valve through the interior of the high-pressure valve and into the body of the steam chest which acts as a receiver. From this it is distributed to the low-pressure cylinder by the action of the low-pressure valve which is set to act in accord with the high-pressure valve and opens the low-pressure ports at the proper time. The final exhaust takes place through the central external cavity of the low-pressure valve which opens a passage to the smoke-box. The tandem method appears well worthy of a further trial in this country, but the time has not yet arrived for judging whether it does in reality possess any superiority to the ordinary method of compounding.

Britain's Biggest Tank Engine.

Brief reference has already been made to the new tank engine, No. 404, designed by Mr. H. A. Hoy, chief mechanical engineer of the Lancashire and Yorkshire Railway, and built at the Horwich Works for the heavy suburban and semi-suburban passenger services of that line—chiefly on the Manchester and Oldham branch, which has gradients as steep as 1 in 41. This massive and splendid-looking engine has a boiler with no less than 2,039 square feet of heating surface—of which 162 square feet are supplied by the Belpaire fire-box—a grate area of 26 square feet, inside cylinders 19 by 26, and six-coupled wheels 5 ft. 8 in. in diameter. Radial axles are given to the leading and trailing pairs of trailing wheels. There are very large tanks and coal bunkers which will hold, respectively, 2,000 gallons of water and 3½ tons of coal, thus enabling the locomotive to carry as ample provisions in these respects as many fairly large tender-engines. The total weight loaded, namely, 77 tons 10 cwt., is distributed as follows: Leading radial wheels 10 tons 12½ cwt.; front coupled wheels 17 tons 19¼ cwt.; middle coupled wheels 17 tons 4¼ cwt.; hind coupled wheels 17 tons 4 cwt.; trailing radial wheels 14 tons 10¼ cwt. A pick-up water-scoop is provided so as to minimise the number of times that water has to be taken in while the engine is at a stand. The new type is obviously of huge power and should prove exceedingly useful on the Lancashire and Yorkshire Railway with its heavy loads, steep grades, and frequent stoppages.

The New Great Western Double-ender.

There is some similarity in general design between the engine just referred to and the newest type of tank engine, No. 99, designed and built by Mr. G. J. Churchward, locomotive superintendent, for the Great Western Railway. Like the Lancashire and Yorkshire engine, it has six-coupled wheels 5 ft. 8 in. in diameter with leading and trailing carrying pairs; it also has a Belpaire fire-box. But here the likeness virtually ends. The cylinders of the Great Western engine are placed outside, those of the Lancashire and Yorkshire are inside the frames. The Great Western cylinders are 18 in. in diameter with a 30-in. piston stroke instead of being 19 in. in diameter with 26 in. stroke, as in the case of the Lancashire and Yorkshire. Mr. Hoy's engine has a flat-topped dome; Mr. Churchward's No. 99 takes steam from a point in the greatest diameter of the tapering boiler. There is, therefore, a very marked difference even in the external appearance of the two locomotives. Moreover, the Great Western engine has considerably less heating surface than the other one, namely, 1,518 square feet. It will be noticed that the exceptional length of piston stroke 30 in., introduced by Mr. Churchward in his 4-6-0 express class, is being used also in his large "Consolidation" goods engine and now in this new design of tank engine. Here, again, much interest will necessarily attach to the experiment whether the tractive advantage naturally secured by the increased length of stroke is or is not counterbalanced by any drawback. It is understood that the two ten-wheel six-coupled express engines, of which casual mention has already been made in passing, will come into regular main-line work ere long, having hitherto been undergoing a series of tests and trials. It has been found advisable, I understand, slightly to strengthen a few bridges which have not hitherto been subjected to the strain of a 69-ton engine running over them. There seems every reason to anticipate that these fine-looking engines with their six-coupled 6 ft. 8 in. driving wheels will give a very good account of themselves on the fast and heavy expresses between Paddington and Plymouth, should it be found judicious to run one engine through the whole distance of 246 miles.

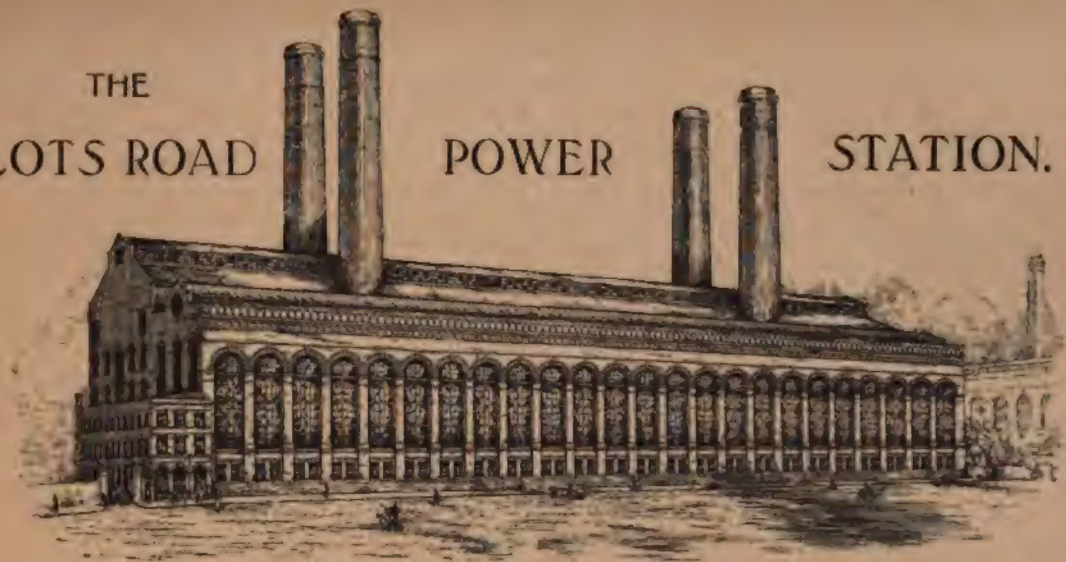
"La France."

There is no reason to doubt that the du Bousquet-de Glehn compound, No. 102, "La France," will acquit herself as well on this side of the Channel as on the other. The engine made her first trip on regular duty on the 2nd ult., taking the twelve noon semi-express from Paddington to Swindon, stopping at Reading by the way. The trip was in no sense a "trial" one. The engine was simply put, for her inaugural run, on a supremely easy task, namely to take a train, weighing well under 200 tons behind her tender, at an average start to stop speed of barely 44 miles an hour over an almost dead-level road. It is needless to say that this excessively light duty was performed without the smallest trace of effort. Reading was reached eight minutes in advance of booked time, and Swindon after five minutes delay, five minutes early. Up a 10-miles continuous slight gradient of 1 in 1,320 a speed of 67·2 miles an hour was attained and maintained. This, however, was manifestly child's play to a locomotive whose sister-engines have reached and sustained a speed of 75 miles an hour with a similar load up a gradient of 1 in 200. The sole point at issue is whether in virtue either of efficiency or of economy—the latter either in construction-cost, expense of maintenance, or consumption of fuel and lubricants—the French engine will prove to possess any material advantage over the very fine and efficient machines most recently designed and built for the Great Western Railway by Mr. Churchward, namely the "City" and "98" classes. That obviously can be determined satisfactorily only by practical experiment. In either case the reputation of neither class of engine will be prejudiced by the result. Both are admittedly admirable of their kind and thoroughly efficient. The real point at issue is whether it will be found desirable and advantageous for Britain to adopt the de Glehn system of compounding.

Great Western Steam Pressure.

As a question has been raised as to the working steam pressure of the Great Western "City" class, I may state that the designer and builder, Mr. Churchward, informed me in writing that their working pressure is 180 lb. per square inch, although the boilers are constructed to carry 195 lb., should this at any time be required. The newest Great Western express engine No. 171 is to have the same pressure as "La France"—viz., 228 lb.

THE LOTS ROAD POWER STATION.



THE LOTS ROAD POWER STATION AS IT WILL APPEAR WHEN FINISHED.

BY

HERBERT C. FYFE.

A short description of the power station which is being constructed at Lots Road, Chelsea. It will be the largest in the world, and will have a most important bearing upon the development of electric traction in the metropolis, while several of its engineering features are unique.—ED.

THE great generating station which is now rapidly nearing completion in Lots Road, Chelsea, is noteworthy for so many reasons that a brief account of some of its most important features may be acceptable.

This immense power house will furnish current for the working of the Metropolitan District Railway and the three "Tubes" now under construction, and controlled by the "Underground Electric Railways Company of London, Limited," viz. :—

(1) Baker Street and Waterloo.

(2) Charing Cross, Euston, and Hampstead.

(3) Great Northern, Piccadilly and Brompton.

The total length of these lines is over sixty-three miles, the District Railway accounting for about forty. The work of laying the two conductor rails over the District system is now being rapidly pushed forward.

The Lots Road generating station is noteworthy for three reasons :—

(1) It will be the first great power house to employ steam turbines exclusively.

(2) It will be the largest electric traction station in the world.

(3) It will contain the largest steam turbines ever built.

The British Westinghouse Company are supplying these turbines, which will be ten in number, and will be of the Parsons type, with Westinghouse modifications. The speed will be 1,000 revolutions per minute. Mounted on the same shafts will be in each case a three-phase generator of 5,500 kilowatts. These will only have four field-magnet poles, and they will produce the energy at a potential of 11,000 volts, which is the highest pressure yet employed for traction purposes in Great Britain. The periodicity will be thirty-three-and-a-third per second.

The Westinghouse steam-turbine is of the Parsons parallel flow type, with such modifications as the experience of Westinghouse engineers in such work has suggested.

Owing to the absence of lubricating oil in the working cylinders, very high superheat can be used with advantage, and this, together with a high vacuum in the condensers, conduces to considerable steam economy.

The 5,500 kilowatt sets will occupy a floor space of 50 ft. long by 14 ft. wide.

The turbine itself is 29 ft. long over all, by 14 ft. wide and 12 ft. high; the rest of the space is occupied by the electric generators.

The principal advantages of the large rotary engine as compared with ordinary engines of the reciprocating type, may be summed up as follows :—

(1) Complete absence of vibration.

(2) Increased economy in steam and coal consumption.

(3) Facility for using high superheated steam with further economy resulting.

(4) Saving of floor space, due to the smaller size of dynamo possible, and the small size of the turbine as compared with ordinary engines of the same horse-power.

(5) Absence of oil from condensed steam.

(6) Uniformity of turning moment.

(7) Reduced cost of other classes of machinery.

(8) Reduced consumption of oil and stores.

With regard to the saving of floor space, it has been computed that if reciprocating engines were used in the Lots Road Station, running at seventy-five revolutions per minute, the diameter of the generators would have to be about 32 ft., whereas the fast-running dynamos actually to be employed will be little more than 9 ft. in diameter. The generators, owing to their high speed of rotation, are very much smaller than corresponding slow-speed machines would be.

THE BUILDING AND ITS SITE.

The site comprises 3·67 acres of land, with a water frontage on the Thames and on Chelsea Creek of 1,100 ft., and a frontage on Lots Road, Chelsea, of 824 ft. There are two hundred and twenty concrete piers sunk to a depth of 35 ft. in the London clay.

The building is 453·5 ft. by 175 ft., and 140 ft. in height from the ground floor to the peak of the roof. The office building adjoining on the east, measures 81 ft. by 25 ft., and will have three floors, the lower of which forms the machine shops. The main building will have a self-supporting steel frame weighing about 5,800 tons. There will be four chimneys, each 19 ft. internal diameter and 275 ft. high; the foundations for these chimneys are 42 ft. square and 34 ft. 6 in. below the ground floor level. There are 2,200 cubic yards of concrete in each foundation.

The capacity of the building at normal load is 57,000 kilowatts. On this basis the cubic feet per kilowatt (including office building) is 139, and the square feet per kilowatt is 1·36.

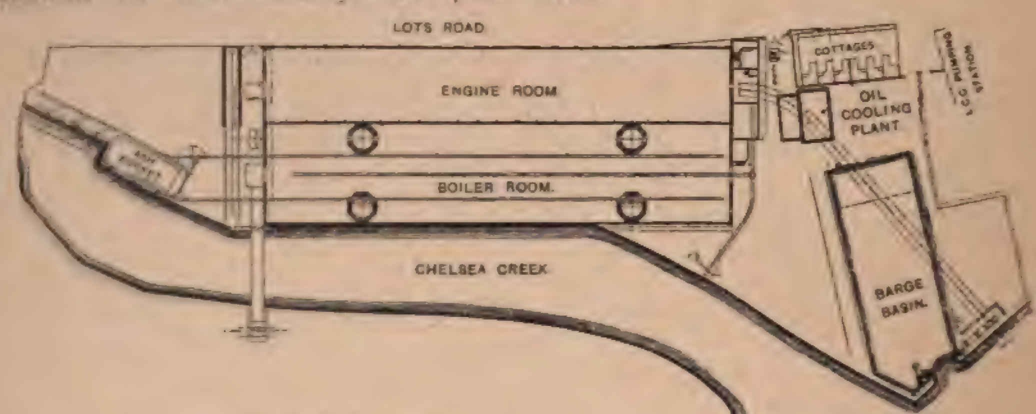
The steel frame of the building will be closed in with brick and terra-cotta; the roof and most of the floors will be concrete. In general details the building will be considered as a factory for the production of a commodity, and there will be no ornamental features.

BOILERS.

The south side of the building will contain eighty water-tube boilers arranged on two stories, a novelty so far as traction stations in this country are concerned, and carried directly on the steel frame of the building. Each boiler has 5,212 square feet of heating surface, and 672 square feet of superheating surface. The boilers will be piped in groups of eight, each group supplying the steam for one electric generating set and one feed pump, there being no steam connections between the several groups, except that a supplemental header at the east end of the building is connected to two groups. This header supplies the exciter engines, air compressors, house pump, etc. Chain grate stokers under each boiler have 83 square feet of surface.

Economisers with tubes 10 ft. long, and placed wider apart than the usual practice, are grouped behind the boilers, with the customary by-pass flues; 1,540 square feet of heating surface is provided for each boiler.

Boiler feeders are placed on the ground floor, and supply ring mains on both the boiler room floors.



LOTS ROAD POWER STATION.

Diagram showing appropriation of the site.

TRANSVERSE SECTION THROUGH ENGINE AND BOILER ROOMS.

MAIN GENERATING SETS.

These consist of a horizontal turbine engine running at 1,000 revolutions per minute, and a three-phase generator wound for 11,000 volts $33\frac{1}{3}$ cycles; there will be ten such sets (supplied by the British Westinghouse Company), with floor space for one of half the size. The normal rating of each generator is 5,500 kilowatts, but they will carry an overload of 50 per cent. for two hours at practically the same steam consumption per kilowatt hour.

There will be four 125-kilowatts, 125-volt steam-driven exciter sets running at 375 revolutions per minute.

The switchboard (provided by the British Thomson-Houston Company) is carried on three gallery floors extending across the north side of the engine-room, with returns across the east end. All high-tension switches will be motor operated, and the feeder system extending to the twenty-three sub-stations will be in duplicate. A line a mile long, of sixty-four ducts is completed to carry these feeders to the nearest point on the District Railway at Earl's Court, where they will diverge to the various sub-stations. The current used at the pilot switchboard will be low pressure from a secondary battery, and it will work the motors at the main board, which will operate the main switches. There will be about three miles of wires about the switchboard.

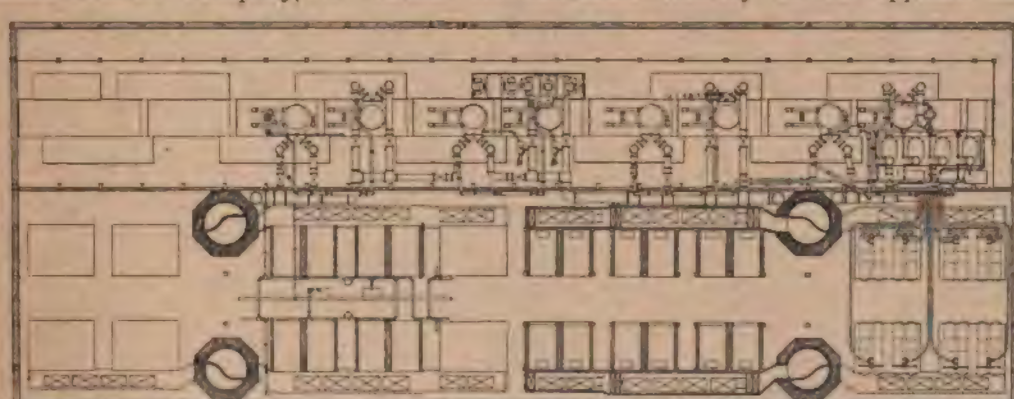
THE CONDENSING SYSTEM.

This consists of vertical condensers each with 15,000 square feet of cooling surface; these are located in pits between the engine foundations. The circulating water is supplied by 66-in. pipes laid to the edges of the channel of the Thames. Each condenser has a 20-in. centrifugal pump; the duty of this pump is simply to overcome the friction of the pipes as the system is arranged on the syphonic principle; the top of the condensers being within 29 ft. of minimum low tide, and the circuit is closed. The intake and discharge mains are arranged for reversible flow.

The condensers are designed to work on the dry vacuum principle, the air pump and the water pump being separate. All the condenser pumps are electrically driven.

FUEL SUPPLY.

Coal will be received on lighters in a tidal basin at the east end of the station, or by rail at an unloading point of the West London Extension Railway on the opposite side of



ARRANGEMENT OF STEAM AND EXHAUST PIPING.

Chelsea Creek. For unloading barge coal the basin is spanned by two travelling cranes, each working a one-ton grab; the coal is weighed in the tower at one end of each of these cranes, and dropped on to a belt conveyor, thence by duplicate inclined elevators 140 ft. high to the top of the building.

Rail coal will be taken from a hopper under the coal wagons by an inclined elevator to the top of the building at the opposite end. The distribution over the bunkers is by duplicate belt conveyors so arranged that the direction of travel of both belts can be reversed so as to handle coal coming in at either end.

The storage capacity of the bunkers is 15,000 tons. The daily consumption will reach 800 tons when the station is in full operation, and six of the largest river barges can be placed in the basin at each tide.

Ashes will be removed by an industrial railway worked by a storage battery locomotive; two lines of rails will be laid under the ash hoppers on the ground floor. The ashes will drop into self-dumping buckets to be unloaded into barges by pneumatic hoists on the dock wall at the west end of the premises, or stored in an adjoining bin if no barge is available.

The capstans, barge basin gate mechanism, and many of the large valves in the building, will be worked by pneumatic motors.

The electric motors on the travelling cranes over the engines, as well as those on the oil switches, will be d.c. 125 volts. All other motors will be three-phase 220 volts; most of the lighting will be on the latter circuit.

PROGRESS OF THE WORK.

Each of the four chimney stalks will be 275 ft. high. Each is 19 ft. internal diameter at the base, and the foundations are 42 ft. square, and 9 ft. deep. The chimneys are of brick, and are constructed on the Custodis principle by the Alphons Custodis Chimney Construction Company. At the present time over 800 men are working at the foundations night and day. The foundations have to go down to the London clay, a depth of about 35 ft. The contractors for this part of the work are Messrs. Perry and Co. Like so many modern power stations, the building will consist of a steel framework clothed with brick. The total quantity of steel to be used in the frame is about 5,800 tons. It was supplied by Messrs. Hein, Lehmann and Co., Düsseldorf. The British Westinghouse Electric and Manufacturing Company obtained the contract for the whole framework to be erected. They sublet the supply of the steel work to the German firm, and the erection to Messrs. Mayoh and Haley. The machinery and boilers can be put in before the brickwork is finished, as the steel frame is absolutely self-supporting, and canvas sides can be supplied if necessary until the brickwork is finished.

The contract for the boilers and stokers has been given to Messrs. Babcock and Wilcox. An unusual feature in traction stations in this country is the fact that the boilers are to occupy two floors, one above the other. The contract for the big switchboard, which will control the supply of current to all the sub-stations on the District and its associated railways, has been let to the British Thomson-Houston Company, while Messrs. J. M. Simpson and Co. are supplying the condensers. The exciter engines are being built by Messrs. W. H. Allen and Co.

INTERIOR OF ONE OF THE CHIMNEY SHAFTS.

One of them is already running at the temporary power station previously referred to, and is furnishing light for the contractors, driving cranes, working an air compressor for pneumatic riveting, etc. There will be four of these engines, each of about 175 h.p., and each driving a British Thomson-Houston exciter dynamo. This plant will be sufficient to furnish exciting current for the fields of the ten main generators. The compressed air apparatus has been supplied by the Consolidated Pneumatic Tool Company.

An interesting travelling electric crane was erected by Messrs. Jessop and Appleby, Leicester. It is of exceptional capacity, as it is capable of lifting thirty-five tons. The crane is erected close to the side of the creek, and it is used for lifting material and machinery from the barges and for handling these things on the site. It can lift the material from the barges and deposit it on platforms 19 ft. above in the power station.

In regard to the sub-stations, the actual positions of these on the District Railway are as follows: Whitechapel, Mansion House, Victoria, South Kensington, Earl's Court, Putney Bridge, Ravenscourt Park, Mill Hill Park, Hounslow, Sudbury. There will be approximately twenty sub-stations for the whole system, divided up between the "tubes" and the existing District Railway lines

The high tension feeder cables come from the British Insulated and Helsby Cables, Ltd., and the stoneware ducts from Doulton and Co., Ltd. The station was designed by Mr. James R. Chapman, General Manager and Chief Engineer of the Underground Electric Railway Company, and Mr. J. W. Towle is the engineer in-charge at the station.

Though the power station can easily be finished long before most of the new railways will be ready, every effort is being made to push on both the building and the machinery, because the sooner the station is finished the sooner will it be possible to work the District Railway itself electrically.

Photo by Elliott and Fry.]
THE LATE MR. W. G. MCMILLAN, F.I.C., F.C.S.,
Secretary of the Institute of Electrical Engineers.

OBITUARY.

THE sudden death from heart failure of Mr. W. G. McMillan has removed one of the best-known figures in the electrical world of the metropolis. It was occasionally our privilege to consult the late Secretary of the Institute of Electrical Engineers on matters concerning that body, and at such times one hardly knew whether most to admire the wonderful grasp of detail, which made him a force, professionally, or the personal characteristics of the man.

It was impossible to be long in Mr. McMillan's company without discovering that he was essentially a worker. With quiet deliberation and unfailing courtesy he seemed to carry in his own personality the very life of the institution, whose interests he had so much at heart. He was a man to whom those in search of information appealed with confidence, and rarely, if ever, were they sent empty away.

His indefatigable exertions on behalf of the members who joined the Italian trip are still fresh in mind, and little did we think, when Mr. McMillan conducted us over the new premises of the Institute shortly afterwards, that his useful work would so quickly come to an end.

Born in 1861, Mr. McMillan was educated at King's College School, and subsequently at King's College, where he ultimately joined the staff. Appointed by the Indian Government in 1888 as chemist and metallurgist to the Cossipore Ordnance Factories, near Calcutta; he also acted as Examiner in Chemistry to the University of Calcutta. During the time which elapsed between his return from India and his acceptance in 1897 of the post of Secretary to the Institution of Electrical Engineers, he turned his attention more particularly to the literature of electro-metallurgy with conspicuous success. He was an abstractor of the Society of Chemical Industry, a Fellow of the Chemical Society and of the Institute of Chemistry, a member of the Institution of Mining and Metallurgy, and in 1897 he was elected Vice-President of the South Staffordshire Institute of Iron and Steel Works' Managers.

Famous Technical Institutions

The third of a series of articles describing prominent technical institutions at home and abroad. The Massachusetts Institute of Technology was dealt with in the January number of PAGE'S MAGAZINE, and in the February issue a description of the Birmingham University was commenced. The author will conclude his remarks on this well-known centre of technical education in our April issue.—ED.

II.—THE BIRMINGHAM UNIVERSITY.

BY

C. ALFRED SMITH, B.SC., A.M.I.E.E.

PART II.

THE FOUNDRY AND FORGE.

WE mentioned in the previous article that there are two buildings adjacent to the power station. Of these, one is divided into the foundry and the smithery. The other is devoted to metallurgical work. The dimensions of the building for a section of the practical part of the engineer student's training is 100 ft. by 25 ft. and in height about 17 ft. It is a rectangular shaped building, with a dividing wall across the middle, leaving each shop 50 ft. by 25 ft. The equipment of the smithery will consist of twelve fires, and a motor-driven 3-cwt. power hammer fitted by Messrs. Thwaites Bros., of Manchester. In the foundry there will be a 2-ton cupola and brass-melting furnace, core stoves and an overhead crane. The building is quite finished, and the students will shortly be at work in it.

THE MAIN BUILDINGS.

Interesting as the equipment and construction of these three auxiliary buildings undoubtedly are, they pale into insignificance beside the huge laboratories and workshops which will form what is always called the "main buildings." The general arrangement of these buildings may be seen from the illustrations. The magnitude of the scheme is probably not realised even in Birmingham itself, where the keenest interest is naturally taken in the new University. When it is remembered that the work and equipment of the buildings, already in hand, will cost almost half a million pounds, and that the maintenance, rates, and salaries of the staff, when once these buildings are completed—the probable time being next October—will probably be about or beyond £10,000 a year, some idea of the effect of this great outlay may be obtained. It is true that at present only four blocks are being built, the ultimate idea is to have ten blocks which it is estimated will cost upwards of a million pounds to build. The time for this to take place will, of course, depend solely upon financial considerations. However, the work in hand is large enough to overshadow anything else yet attempted in this country, although it is true that there are universities in America which are built on the same magnitude. The most imposing portion will be the central hall, which is 150 ft. by 75 ft., and will be used for great occasions, such as degree congregations and other public functions. Under this great hall there are the dining-rooms and kitchens for the students and staff.

When facing the great hall, the two blocks on the right are those for engineering students. In one of them there will be the electrical laboratory, 115 ft. by 50 ft., and at the end of

THE TECHNICAL STAFF.

ENGINEERING, MINING, AND METALLURGY.

Mr. R. C. PORTER, M.Sc., A.M.Inst.C.E. Mr. O. F. HUDSON, A.R.C.S. Mr. F. H. HUMMEL, A.C.G.I., A.M.Inst.C.E.
Prof. R. A. REDMAYNE, M.Sc., F.G.S. Prof. BURSTALL, M.Sc., M.A., M.Inst. C.E., M.I.M.E. Prof. T. TURNER, M.Sc., A.R.S.M.
Mr. C. A. SMITH, B.Sc., A.M.I.E.E. Mr. E. H. ROBERTON, B.A. Dr. D. K. MORRIS, Ph.D., A.M.I.E.E.

the block will be the hydraulic laboratory, 42 ft. by 110 ft. There will also be a large strength of materials laboratory for testing iron and steel. The general equipment of these are already decided upon, but as the contracts have not yet been let it is not possible to give a detailed description.

In the adjacent block there will be the hall of machines, the dimensions of which are 115 ft. by 50 ft. In the old buildings at Edmund Street there are some fine specimens of up-to-date machinery; and the students there have turned out, among other work, during the past year, half a dozen lathes, and some motor-driven three-throw pumps. This machinery will be moved out to Bournbrook shortly, and will be largely added to. Mention should also be made of the spacious drawing office, which will accommodate at least 100 students at one time. There will also be a special room for taking blue prints, which work the students will have to do for themselves.

A FOUR YEARS' COURSE.

It cannot be denied that the engineering course at Birmingham is a great experiment. It more nearly resembles the curriculum which the Admiralty have had in operation for the last fifteen years at Keyham College, Devonport, than any other training institution in England. It is based distinctly on opposite lines to that of the advocates of the "sandwich system," for it offers to teach the engineering student both theory and practice at the University. Its only weakness lies in the fact that, whereas the Admiralty trained engineer is brought fully into contact with the men in the shops, the Birmingham graduate will need yet another year, possibly as an improver at a small wage, in the shops in order to study that complex character, the British working man.

For the first two years all the engineering undergraduates take the same subjects. Great attention is given to mathematics, physics, chemistry and mechanical drawing. Elementary descriptive lectures in mechanical, civil and electrical engineering are also given. In the third and fourth years the student specialises in one of the above branches, and those who successfully pass all their examinations are, at the end of the four years, entitled to the degree of Bachelor of Science in engineering. In the later part of the course attention is directed to experimental work in the engineering laboratories, which are fitted with the most modern appliances. The strength of materials laboratory contains a 50-ton testing machine, a torsion testing machine, and a cement testing plant. Hydraulic tanks are also provided for the investigation of the laws governing the flow of water through pipes and orifices. There is also a journal testing machine. The new power station at Bournbrook constitutes the heat engine laboratory. The electrical engineering laboratory is provided with appliances for all classes of electrical testing work. There are a large number of small motors, continuous current, single, two and three-phase machines, upon which the students perform tests. There is also a 7½-kilowatt Westinghouse rotary converter. A photo-metric gallery provides for arc and glow lamp testing, and a separate room is reserved for standardising of instruments, testing of insulation, magnetic qualities, etc. There are a large number of the best known modern types of switchboard and other instruments.

Great attention is given to drawing office work in all three branches of engineering. In the third and fourth years all the time is devoted to design work.

The engineering students—in accordance with the degree syllabus and their own discretion—attend courses of lectures in metallurgy, mining, geology and commerce. This later faculty is a disinctive feature of the University and seems to be flourishing greatly. Some of the students have also been known to find time to attend lectures in modern languages.

A tribute should be paid to the valuable work done by the University Engineering Society which, during the past two years, has been completely re-organised. Papers are read, debates held, and works visited under its auspices, and there is published in connection with it a "University Engineering Journal" for printing full reports of the meetings.

The detailed equipment of the mining and metallurgical sections will be dealt with in a later article.

(To be continued.)

A High-Speed Gravitation Stamp Mill.

BY

EDGAR SMART.

A new type of stamp mill has recently undergone a thoroughly practical trial, under normal working conditions, at the Meyer and Charlton Mine in Johannesburg. The results obtained constitute such a marked advance on existing practice, that a description of the principal features of the improved stamp operating mechanism cannot fail to be of interest. The machine has been carefully and thoughtfully worked out in all its details, and, apart from its interest as a crushing mill, it is of considerable interest as a study in applied mechanics.—ED.

IN a previous article on ore milling,* it was stated that the practical limits of speed for a gravitation battery of the ordinary type were about 95 drops per minute for a 9-in. drop, or 100 drops at 6 in. Reference was also made to some modified forms of stamp mechanism, which aimed at increasing the velocity of fall. An increase in the number of drops per minute, as well as in the energy of each blow, has been achieved by steam and pneumatic stamps, of which latter the Husband stamp is a well-known type, but neither of these forms has so far come into general use.

The battery about to be described differs from those mentioned above in that its object is not to accelerate the *fall* of the stamp, but to obtain a greater rapidity of action by means of a quicker *lift*. Therefore, although the cam is dispensed with, the machine is purely a gravitation battery, and, so far as the blow on the ore is concerned, it in no way differs from the ordinary type except that the stamps are of greater weight.

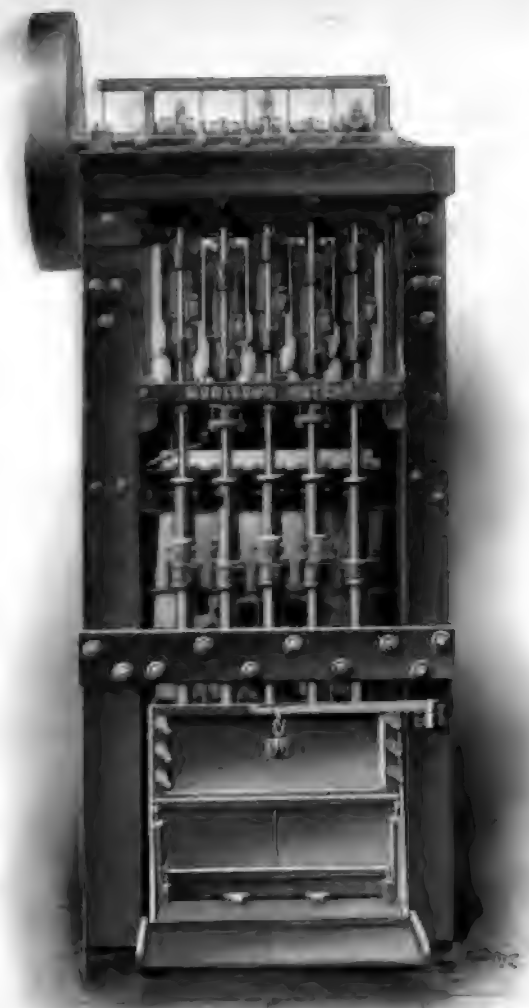
The invention is due, in the first place, to Mr. D. B. Morison, the well-known marine engineer and managing director of Richardsons, Westgarth and Co., Ltd., of Hartlepool; but in working out the details he has had the valuable assistance of Mr. D. A. Bremner, the managing director of the High-Speed Stamp Company, who personally superintended the trial of the new stamps at the Meyer and Charlton mine. Mr. Bremner has not only placed a large quantity of information concerning the machine at the author's disposal, but has also afforded every facility for the personal examination of the mill and its work, which is necessary in forming an independent opinion of its merits.

* Vol. I., page 315.

CHIEF POINT AGAINST THE CAM.

The mill in its present form is the outcome of a practical trial of an earlier form and of more than five years' experimental work on a large scale by Messrs. Morison and Bremner, who have, during that time, carried out a number of systematic tests in crushing with cam stamps, as well as with the high-speed battery. They have pointed out in communications to engineering societies, certain disadvantages inherent in the cam system, and which they have endeavoured to avoid in the new design. Of the various objections raised by them, the following appears to be the most serious and the most valid:—

The vertical motion of an involute cam, turning at a uniform velocity, is uniform throughout the lift, so that at the pick-up point the cam endeavours to lift the stamp immediately at full speed; but this is impossible because the stamp, being at rest, cannot instantaneously



Mortar Box Closed.

Mortar Box Open.

A BATTERY OF 1,600 LB. HIGH-SPEED STAMPS.

acquire the velocity of the cam. It is certain, therefore, that the motion of that part of the cam face, which is in contact with the tappet, must be retarded at the moment of impact. This involves either the yielding of the cam by bending or a local twisting of the cam shaft at each pick up, or, more probably, both of these effects together.

This objection is, of course, more theoretical than practical as regards cam stamps working under the conditions usual at the present time, for experience has abundantly proved that there is no difficulty in providing the necessary strength to bear these strains, large as they undoubtedly are. The importance of the point raised is in relation to the question of increasing the present limits of speed, because the objectionable strains above referred to, increase as the square of the cam velocity. As a mere matter of geometry, increased speed can be obtained by placing the stems farther from the cam shaft, so that the radius of the generating circle of the involute is larger, and the angle of rotation required for a given lift is consequently reduced. The same result can also be obtained in other ways, but in whatever way the vertical velocity is increased, the stresses on cams and shaft will be correspondingly intensified at the moment of pick up, and this may therefore be fairly considered as one of the chief factors which limit the possible speed of cam-driven stamps.

The discussion of this matter leads to a clear understanding of one desirable feature in a high-speed mill, namely, the gradual imparting of motion to the stamp. This, again, leads to the idea of an elastic cushion between stamp and lifting mechanism, which is only imperfectly provided in the ordinary battery by the yielding of the cam shaft and framing, which has already been mentioned.

THE LIFTING MECHANISM.

In describing the new battery, it will be convenient to commence with the most novel and essential feature, namely, the device for picking up the stamp by means of a cylinder and piston, as shown in fig. 1. This figure differs slightly from the working drawing from which it was derived, in that all the parts necessary to the explanation of the action are shown in one sectional plan, whereas in the machine itself the various passages for air and water are distributed round the cylinder casting.

The cylinder *a* reciprocates vertically, being actuated by a crank and connecting rod, placed above it. A top cover, *b*, carries the pin, *c*, of the connecting rod. At the bottom of the cylinder there is a packed gland, *d*, through which the piston-rod, *e*, passes. A port, *f*, in the side of the cylinder communicates with an annular water chamber, *g*, formed in the casting. Water is supplied to the chamber by the pipe, *h*, and overflows through the hole, *j*, to the escape pipe, *k*. The plain plug piston, *l*, which has no packing, is hollowed out to form an air vessel, *m*, and it has a central passage through it from *n* to *o*. The size of the opening at *o* can be varied when desired by the substitution of another vent plug, *p*, with a larger or smaller hole. This change can be made through the port door, *q*. A screwed plug valve, *r*, is provided for draining all the water from the cylinder when necessary. There are openings, *s s*, at the top of the cylinder, communicating with the water jacket to allow the free transfer of air inwards or outwards according to the relative motion of piston and cylinder.

THE LIFT AND DROP.

Assuming that the stamp is resting upon the ore in the mortar box, and that the piston is therefore momentarily at rest, the cycle of operations is as follows :—

The cylinder completes its downward travel, and reaches the bottom of its stroke as shown in fig. 2. The port, *f*, then being open, the water can flow from the annular chamber, *g*, into the lower part of the cylinder, thus filling the whole space below the piston. It is evident that when the water level rises to the lower end, *n*, of the vent, the air in the vessel, *m*, is trapped. When the cylinder begins to rise, a small portion of the water is forced back through the port, which is, however, being rapidly closed, so that the pressure inside the cylinder quickly but gradually increases, and the trapped air is compressed, until the pressure is sufficient to overcome the weight of the stamp, which must then begin to rise. But, owing to its inertia, the stamp does not at once acquire the full velocity of the cylinder; the air cushion on which it actually rests prevents by its elasticity any excessive strains in the mechanism, and the internal pressure continues to increase until piston and cylinder are moving upward together at the same rate. This state of things is shown in fig. 3. From the high-speed point of view, this gradual pick up is of the utmost importance as it allows of a very rapid lift without developing large initial stresses.

The cylinder velocity increases till about the middle of its upward stroke, and then gradually decreases. The acquired momentum of the stamp, and the expansion of the air beneath the piston, then carry the latter upwards faster

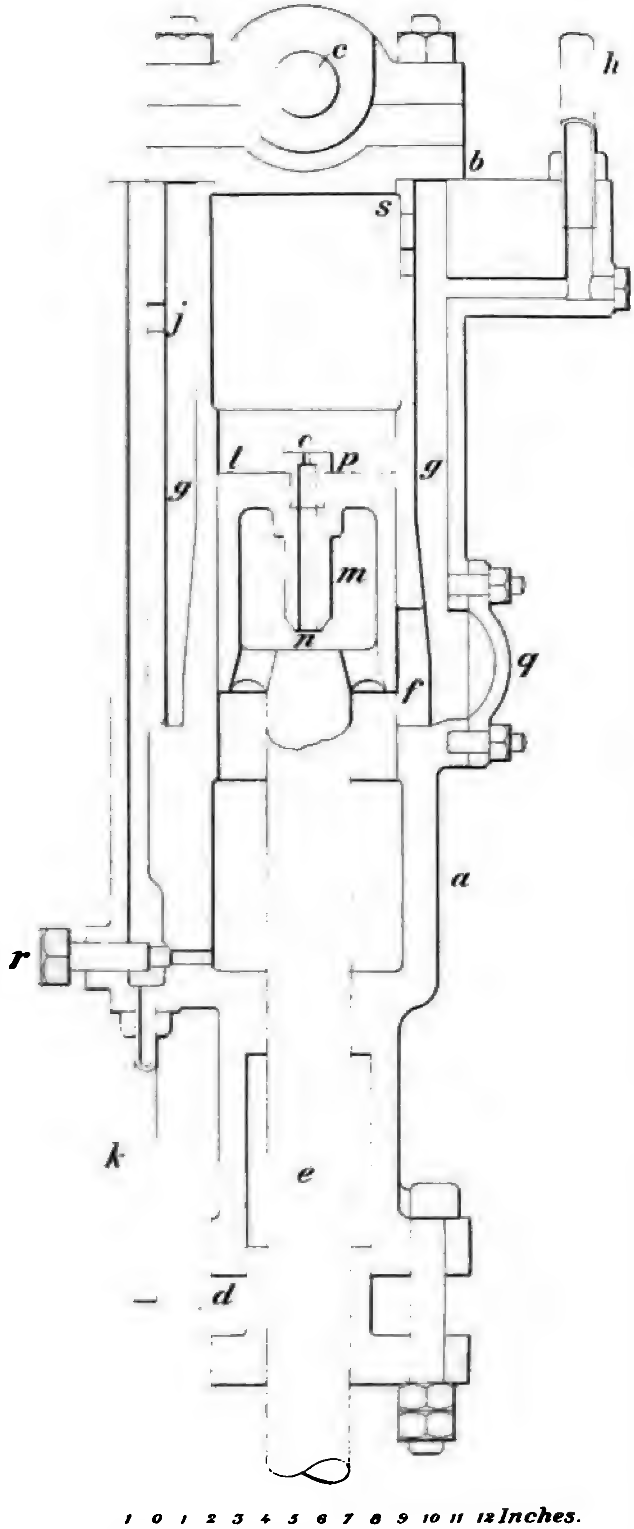


FIG. 1. DIAGRAM OF CYLINDER AND PISTON.

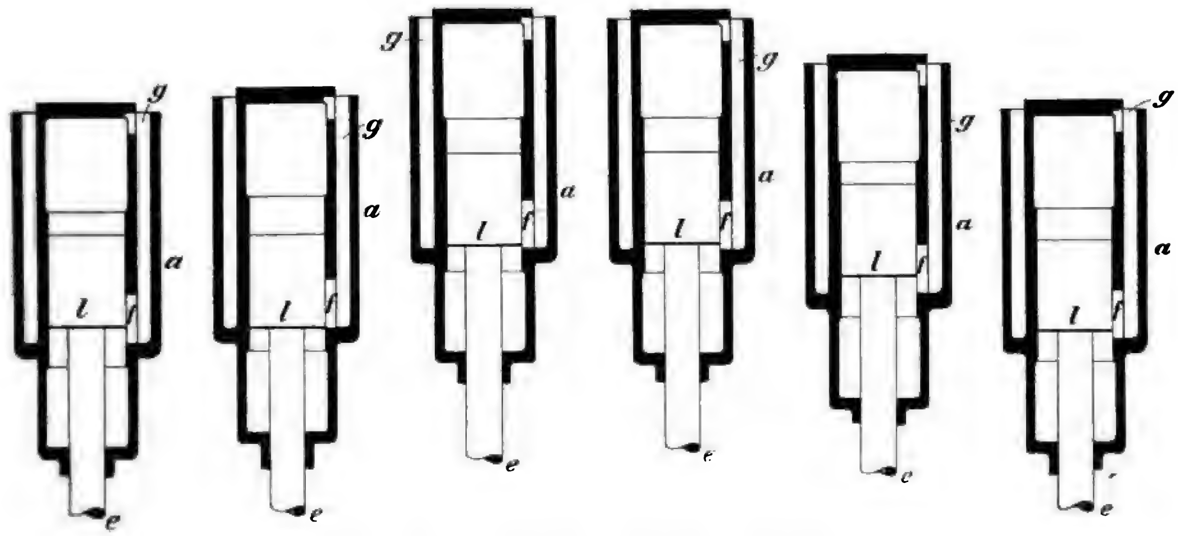
than the cylinder, which, indeed, begins to descend before the stamp has reached the top of its stroke. (See figs. 4 and 5.) By this time, therefore, the port, *f*, is open, and during the first portion of the down stroke it continues to open still more, as in fig. 6, because the cylinder is moving more quickly than the piston. Towards the end of the drop, however, the port is partly closed again, because the speed of the cylinder has somewhat decreased, while that of the stamp has been continually accelerated by gravity. Fig. 7 shows the position when the stamp is just down, and the further descent of the cylinder again increases the port opening until the conditions shown in fig. 2 are again reached, and the cycle of operations is thus completed.

With regard to any possible retardation of the falling stamp, by friction or otherwise, it has been shown by indicator diagrams obtained from the stamps themselves while working, that the total acceleration is somewhat greater than the total retardation, or, in other words, that the fall is a little more rapid than it would be if due to gravity alone. But this is merely a side issue, and does not form a part of the intention of the design. It may be remarked, in passing, that although the vertical motion of both piston and cylinder is about 8 in., yet the *relative* motion between the two is not more than $1\frac{3}{8}$ in.

When the drain plug, *r*, is opened the cylinder continues to reciprocate, but the lift of the stamp diminishes at each stroke until no water remains in the cylinder, when, of course, the stamp comes to rest. When the plug is screwed up, the stamp rises again with an increased lift at each stroke (as the water accumulates in the cylinder and annular chamber) until the normal drop is attained.

LIMITATIONS OF SPEED.

As the fall of the stamp is due to gravity, it is evident that the time occupied by each drop is practically constant, whatever the speed of lift may be. Therefore if the cylinder is reciprocated very rapidly, it will close the port and begin to lift the stamp before the latter has completed its descent, and instead of the shoe falling upon the ore, the piston will fall on the air cushion. For a mill designed to run at 126 drops per minute, the admissible increase of speed, without ill effects, is up to, say, 134 drops. When the speed is reduced, the effect is to lessen the height of lift, so that variation in this direction is also limited on account of the consequent reduction in crushing capacity.



FIGS. 2 TO 7. SHOWING CYCLE OF OPERATIONS.

CIRCULATION OF WATER.

The water is supplied to the cylinders from a small tank above the battery, whence it passes through a channel formed in one of the castings of the upper frame to a small fixed pipe which projects down into the pipe, *h*, shown in fig. 1, on the top of the cylinder. From the annular chamber the water overflows through the opening, *j*, to the pipe, *k*, which projects down into a fixed pipe of larger diameter, which carries the water to another channel formed in the frame, whence it passes to a small pump, which returns it to the tank. Thus, a slow but continuous circulation is maintained in such a manner as to continually aerate the water, to carry off the small amount of heat developed by the cushioning action, and to maintain a sufficient quantity at all times in the cylinder. A lubricant is mixed with the water to minimise friction and to obviate corrosion. In each of the telescopic pipes above mentioned, the inner and outer tubes do not actually touch each other, and therefore no wear or friction results from their relative motion.

ADJUSTMENT FOR WEAR OF SHOES AND DIES.

For this purpose the arrangement shown in fig. 8 has been designed. The lower, tapered end of the piston rod, *e*, is cottered into a sleeve, *s*, about 30 in. long, which also fits on to the top end of the stem, *t*, and when in its lowest position abuts against a collar forged on the latter. The stem is held in the sleeve by a gib and keys, in the same way that the tappets are fixed to the stems in an ordinary battery. The distance from shoe to piston can, therefore, be suitably adjusted by slipping the sleeve up or down on the stem and keying it in the required position.

COMPENSATION FOR LOSS OF SHOE WEIGHT.

For the purpose of combining the above mentioned adjustment with compensation for loss of shoe weight, a number of washers are provided, each ½ in. thick, and shaped like a horseshoe, with the free ends turned down to lock into notches in the washer beneath. When the combined wear of a shoe and die amounts to about half an inch, the stamp is stopped, the keys slackened, the sleeve raised with a crowbar, and a washer slipped in between the flange of the sleeve and the collar of the stem. The sleeve is then dropped on to the washer, and the keys are tightened up. The insertion of the washers between the sleeve and stem flanges also prevents all chance of derangement through slipping of the stem within the sleeve. This simple means of compensating for the loss of shoe weight enables the weight, and therefore the crushing power, of the stamp to be maintained practically constant throughout the life of the shoe. The sleeves also allow of an alteration of the drop within certain limits when required, for by lengthening the distance between shoe face and piston, the latter is raised relatively to the cylinder, so that the pick-up of the stamp occurs later in the stroke, and the total rise and drop are lessened.

STAMP ROTATION.

It is well known that in an ordinary battery the cam acting on one side only of the tappet

imparts a more or less regular rotation to the stamp during each lift. In dispensing with the cam, therefore, it becomes necessary to provide some other means for obtaining a similar slow rotation to secure, as far as possible, uniform wear of the faces of the shoes and dies.

After experimenting with several devices, the following ingenious but simple arrangement has been adopted, which is shown in fig. 9:—

A V-groove is turned in the bottom flange of the sleeve, *a*, which is consequently a horizontal

FIG. 8.

Showing piston rod, *c*, adjusting sleeve, *s*, stamp stem, *t*, and guide blocks, *u*.

V-pulley. About four feet away from this, at the back of the mill, there is a vertical V-pulley rigidly attached to a ratchet wheel, *b*, and carried on a pin, *c*, at the end of one arm of a bell crank lever, *d*, whose other end, *e*, carries a weight, *f*. A short rope belt, *g*, connects the two pulleys, and is kept at a constant tension by the aforesaid weight. The levers for five stamps are pivoted on one shaft, *h*, common to them all. A weighted pawl, *i*, engages with each ratchet wheel, so that the vertical pulley is locked against rotation in one direction, but can turn freely in the other direction.

Considering now the two halves of the rope, marked *n* and *o*, it is obvious that as the stamp falls, the lower part, *n*, will be slackened, and the upper part, *o*, will be pulled towards the stem, thus tending to turn the vertical pulley in the direction of the arrow. The ratchet and pawl being arranged to allow of its motion in this direction, the vertical pulley will therefore be turned through a small angle. When the stamp ascends the upper part, *o*, of the rope is slackened, and the lower part pulled. As the vertical pulley is locked by the pawl against motion in this direction, the altered tensions in the two parts of the rope adjust themselves by rotating the horizontal pulley, and with it, of course, the sleeve and the stamp.

According to the direction of the teeth of the ratchet wheel, the rotation of the stamp can therefore be effected either during its rise or its fall. In practice, the former is preferred because it diminishes the frictional resistance during the lift.

This gear is placed behind the stamps under the platform, which gives access to the cylinders. The ropes of the turning gear can be clearly seen on the sleeves in fig. 8. In future it is proposed to use chains.

THE CRANK SHAFT AND UPPER FRAME.

In this particular mill the five cranks have a throw of 4 in., and are so arranged that the stamps drop in the order, 1, 3, 5, 2, 4. The shaft can, of course, be designed for any order of drop, in the first instance, but this is afterwards unalterable. There is a bearing between each two cranks, as well as one at each end, thus making seven in all, and securing great rigidity, and adequate bearing surfaces. The bearings form part of a cast iron entablature, which is placed on the top of the battery frame, and bolted to two beams, which, in turn, are bolted to the king posts. The entablature and shaft are shown in fig. 10.

The centre line of the shaft is placed $3\frac{1}{2}$ in. in front of the centre line of the stamps, in order

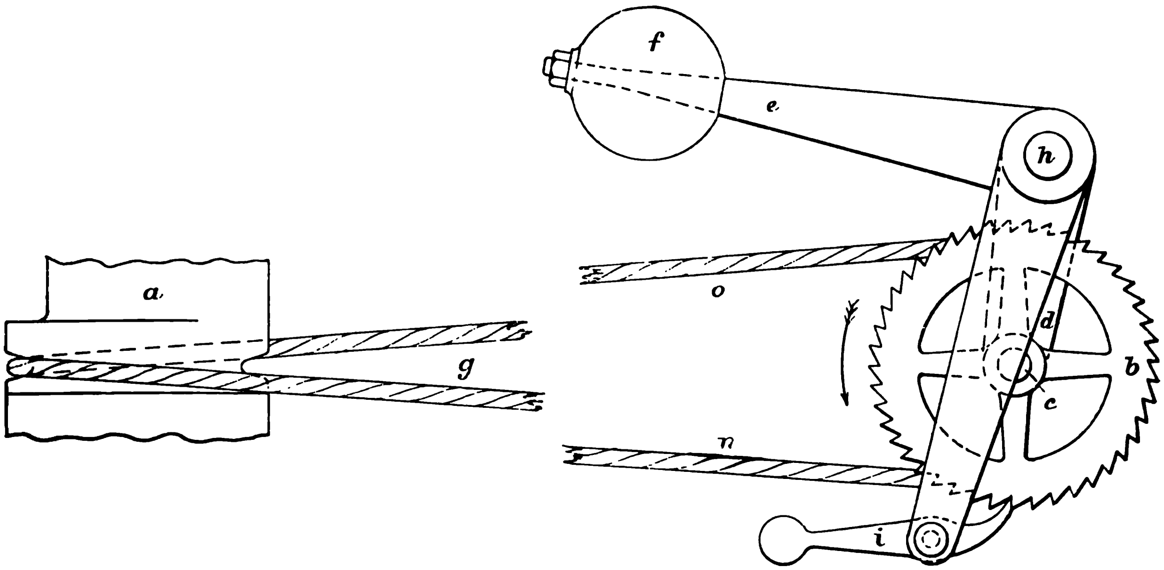


FIG. 9. METHOD OF SECURING STAMP ROTATION.

that the connecting rod may be acting vertically during the loaded up stroke of the cylinder. This is, of course, only strictly true at one point of the stroke, but the arrangement ensures that the angular thrust against the cylinder guides shall be exerted chiefly during the down stroke when the cylinder is running free of any load.

As the five cylinders and connecting rods practically balance each other, no power is expended in raising any weight which does not contribute to the blow of the stamp.

A cast iron frame is bolted to the underside of the entablature at each end of it. These frames are connected by upper and lower cast iron beams, to which the vertical guide rods of the cylinders are fixed. Thus, the whole of the lifting mechanism is contained in one rigid metal structure, quite independent of the timber framing, so that no unexpected stresses due to the warping of the latter can occur. For the purpose of comparison with a cam battery, the mill may therefore be considered as consisting of three parts, viz.: (1) The self-contained lifting machine (including crank shaft, connecting rods, and cylinders), which corresponds to the cam shaft and cams of the ordinary mill. (2) The piston, piston rod, sleeve, and washers, which take the place of the tappet. And (3) the stem, head, shoe, die, mortar box, and timber framing common to both systems.

STEMS, HEADS, ETC.

The stem only differs from that of a cam driven stamp in its larger diameter, decreased length, and in the forged collar previously mentioned, which abuts against the lower end of the adjusting sleeve. Its lower end is tapered, and fits into a conical hole in the head in the ordinary manner. The head and shoe are not only heavier than usual, but also of larger diameter, so that the area of the shoe and die are increased in proportion to the total weight of the stamp. The force of impact per unit of surface is, therefore, approximately equal to that of an ordinary 1,150-lb. stamp. The actual diameter in this case is 11 in., instead of the usual 9 in., and the stamps are spaced at 12-in. centres instead of 10 in. The heads, shoes, and dies are seen in position in fig. 11, and an ordinary shoe is shown standing on the plate at the right-hand side of the mortar box.

MINOR DETAILS.

The propping-up gear deserves a word of notice in order to point out a difference caused by the absence of the cam. In an ordinary battery the stamp must be lifted higher than its normal lift, so that the finger can hold the tappet clear of the still-revolving cam. With the new battery the stamp merely requires to be held at or near the top of its stroke. This is accomplished by means of short forged steel fingers pivoted on pins carried in brackets mounted upon an I beam, which is bolted to

the back of the king posts. These fingers engage with the flanges at the upper ends of the sleeves on the stamp stems, and they are fitted with safety pins to prevent accidental disengagement.

Provision is made for the continuous oiling of the crankshaft and connecting rod bearings by means of a central oil reservoir situated above the shaft.

THE OPEN FRONTED MORTAR BOX.

The new mill at the Meyer and Charlton battery has one other unusual feature, which has, however, nothing to do with the question of speed, and is equally applicable to all types. This is an open-fronted mortar box, with a removable pressed steel front, which is shown in fig. 11. This front plate is dished out to stiffen it, so that it forms a rigid stay between the end walls of the box, to which it is fastened by six screws and nuts. The centre of it is attached by a link and swivel to a bar which can turn on a vertical hinge bolted to the framing. By this means it may be swung right out of the way, and so facilitate the work of cleaning up the mortar box or the renewing of stems, heads, etc.

ACTUAL CRUSHING RESULTS.

During the final stage of the trials carried out at the Meyer and Charlton mine, the high-speed stamps were run continuously for four months, with only the stoppages customary in a stamp mill, and the following results were obtained :—

Average weight of stamps	1,550 lb.
Average number of drops per minute ...	127
Average height of drop	7¾ in.
Depth of discharge	nil.
Screen mesh during July and August ...	500
Screen mesh during September and October	400

Summary of 4 months' trial.

	Hours run. H.	M.	Tons crushed.	Crushing rate per stamp per 24 hours
July ...	576	25	1,013	8·43
August ...	645	25	1,203	8·94
September ...	568	25	1,054	8·90
October ...	599	55	1,167	9·33
	2,390	10	4,437	8.90

CONVERSION OF EXISTING CAM STAMPS.

The suggestion has been made that existing mills could be converted by the substitution of, say, 1,400-lb. high-speed stamps and the erection of the new mechanism on the old frame and foundations. The energy available calculated from weight and drop in several cases is as follows, the drop being 7½ in. :—

A—1,000-lb. stamps, 95 drops, 59,375 ft.-lbs. per min.
B—1,250-lb. stamps, 95 drops, 74,219 ft.-lbs. per min.
C—1,400-lb. stamps, 126 drops, 110,250 ft.-lbs. per min.

A gain in crushing power — assuming this to be always proportional to the energy available — of 86 per cent., would therefore appear to be obtainable by conversion from A to C, and 49 per cent. by conversion from B to C, whilst, in either case, the cost would be but a fraction of that involved in the addition of the *pro rata* number of cam stamps.

FIG. 10. ENTABLATURE AND CRANK SHAFT.
Showing the seven bearings and five cranks.

INSTALLATION OF NEW STAMPS.

It is not considered advisable to construct high-speed stamps of greater

weight than 1,400 lb. on 10-in. centres, inasmuch as it would involve a sacrifice of first-class mechanical design, and therefore, that weight is the limit available for the conversion of existing cam stamp batteries, in which the width between king posts is generally five feet. These limits do not exist, however, in the case of new mills, and although 1,600-lb. stamps at 12-in. centres were decided upon as a satisfactory unit for introduction into mining practice, that weight is by no means the limit. In fact, it is asserted that considerable advantages will be derived from a still further increase of weight, and a corresponding reduction in the number of stamps required for a given output.

FIG. 11. MORTAR BOX OF HIGH-SPEED STAMP MILL AT MEYER AND CHARLTON MINE, JOHANNESBURG.

Showing removable front plate, and heads, shoes, etc., in position.

The writer has been informed that, to meet the conditions prevailing on the Rand, it is intended to standardise an 1,800-lb. high-speed stamp, having double the crushing power of the 1,300-lb. cam stamps now coming into vogue on that field. On this basis, 100 heads of high-speed stamps would be equivalent to 200 heads of cam stamps. It is claimed that, by reason of the large attendant savings in foundations, building, framing, ore bins, battery tables, feeders, and line shafting, the initial cost of a mill on the Rand would be reduced by about 20 per cent. by the adoption of high-speed stamps.

THE MANUFACTURE OF HEXAGON NUTS.

THE accompanying illustrations show a plant for the manufacture of hexagon nuts from 3 in. to 6 in. diameter from round stock. The steel bars are cut up into discs slightly in excess of the depth of the finished nut by a special cutting-off machine. The pieces as they leave this machine are in the form of circular blanks from each of which one nut is made.

They pass to the drilling machine, a substantial tool with three vertical spindles (fig. 1). The spindle heads are attached to a cross rail supported on two uprights. The spindles are balanced and have independent variable feed, with quick hand movement by lever and slow movement by hand-wheel. A stop is fitted disengaging the automatic feed immediately the hole is drilled through the nut blanks. Each spindle has a self-centring jig, into which the blanks are placed, and which is arranged to accommodate all sizes. The jig works on the table of the machine, and is provided with a set of steel bushes to suit the twist drills used for smaller nuts and the trepanning bits that are used for larger sizes. They are arranged so that the nuts may be slid between the gripping jaws and withdrawn without effort, a small platen being attached to each jig, having its surface just level with the bottom of the vice in which the drilling is done. A water-tank is fitted beneath the table and a small pump supplies a stream of lubricant to each drill.

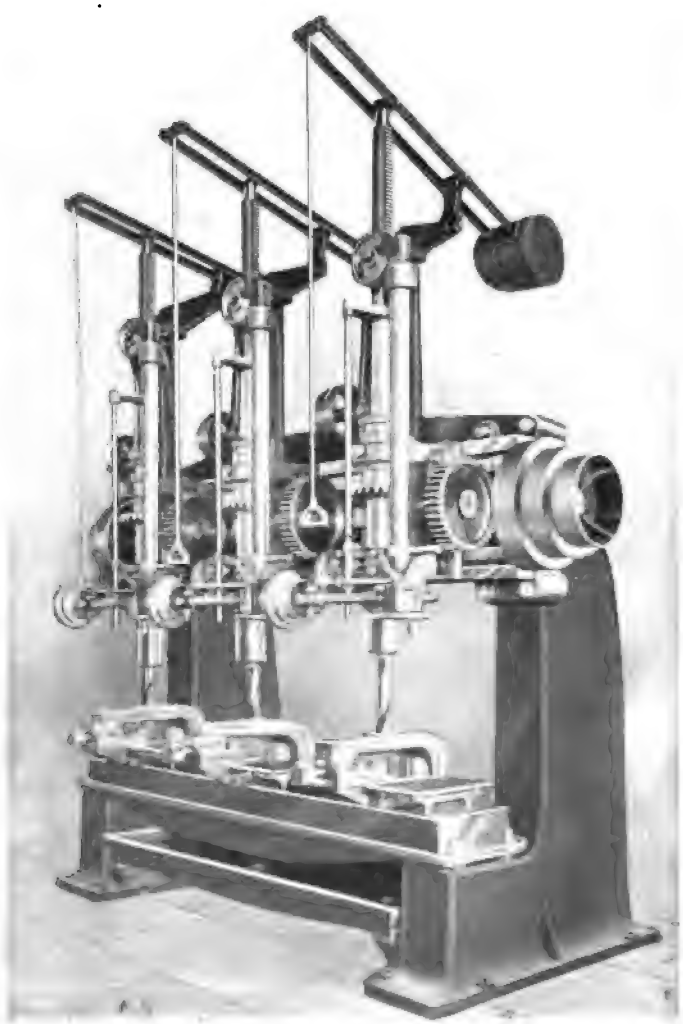


FIG. 1. THREE-SPINDLE DRILLING MACHINE.

The drilled blanks now pass on to the tapping machine, which is shown in fig. 2. This machine may be driven through either double or triple gearing, and in each case a range of five different speeds are available without alteration of belt and without stopping the machine This variation of speed is obtained by the nest of gears plainly seen in the headstock. The blanks are held by suitable means on the carriage, the motion of which is accurately governed by a stout guide-screw running in the centre of the bed, which is engaged by a double clasp nut. Change wheels to suit the pitch of thread are accommodated at the right hand end of the bed. The quick motion to the carriage is obtained by rack

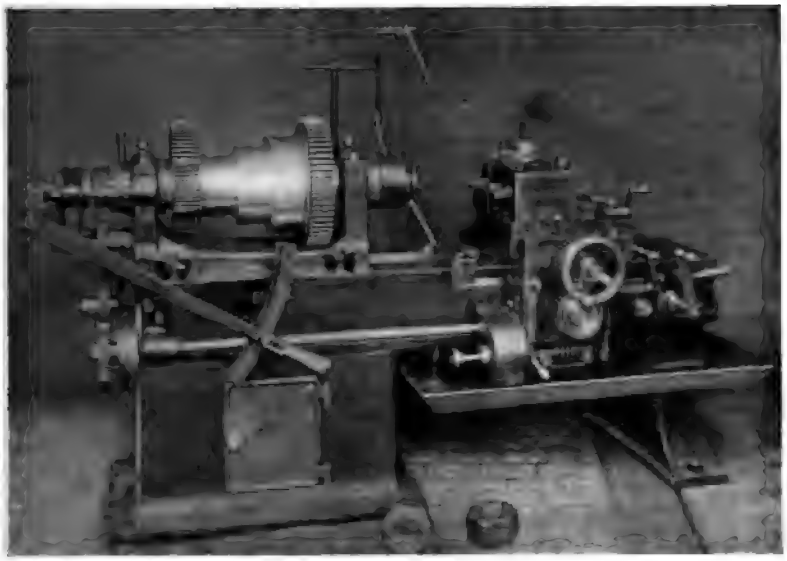


FIG. 3. NUT FACING AND CHAMFERING MACHINE.

The nut is slipped into position and the mandrel is then expanded to grip the threads inside the nut. It screws itself home again against a rocking washer, and operations commence immediately. As soon as the work is done, the mandrel collapses by means of the controlling hand-lever and the nut is slipped off. The mandrel is in the form of four loose jaws, which are threaded to suit the nut, and a set of jaws is supplied for each size of nut.

When the nut is faced on both sides and chamfered, it passes to the hexagon milling machine, shown in fig. 4. Two or more nuts are placed on the mandrel, which has a regular circular feed by worm and wheel. Behind this is situated a cutter headstock, which is mounted on a slide so as to be capable of a reciprocating motion to and from the work. This reciprocating motion is governed by a pair of cams at the rear of the machine, and in the case of hexagon nuts, are connected to the work mandrel by change gears, so that the cams make six revolutions whilst the nuts turn once.

and pinion movement actuated by a hand-wheel. The tap fits loosely in a square chuck on the spindle nose and feeds right through the nut, a stream of lubricant being directed on to the work during the operation.

The pieces are now brought to the nut-facing and chamfering machine (fig. 3), a special double geared lathe with carriage accommodating three tools and fitted with automatic cross transverse. A handle on the carriage controls the two rates of feed that are available and a drop-out worm-box disengages the feed at any desired point. First the roughing tool and then the finishing tool traverses over the face of the nut, after which the rate of feed is reduced by the handle change gear and the chamfering tool comes into operation. The nuts are held on their threads by means of a collapsible mandrel which projects from the spindle nose. This is controlled by a long hand-lever working off a fulcrum at the tail-end of the spindle.

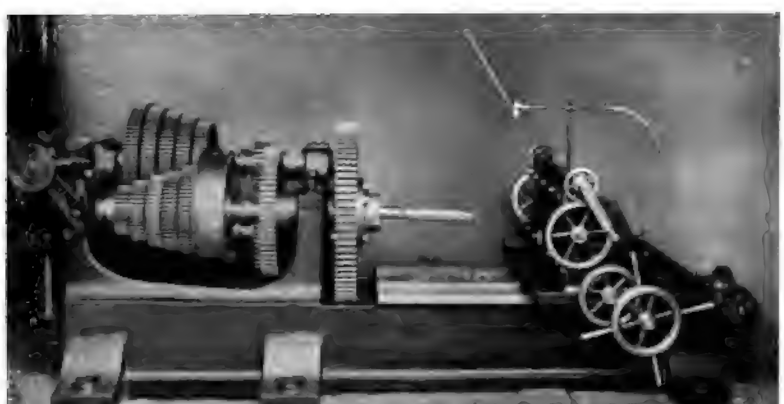


FIG. 2. NUT TAPPING MACHINE.

The cams are so shaped as to give the requisite motion to the cutter head enabling the milling cutter to remove the material and form the side of a nut correctly. Side after side is thus formed without an interval and without attention from the operator until the nuts have made one complete revolution, when the self-acting feed becomes disengaged automatically and the nuts are completed. The machine may be set instantly for doing any size of nut without change of cams, and the work is turned out most expeditiously.

The whole plant is efficient in its operations, and it has been proved that nuts can be produced complete and bright all over at the cost of making rough forgings from which these nuts are usually manufactured. For the photographs illustrating the above plant we are indebted to the makers—Messrs. John Holroyd and Co., Ltd., of Milnrow, near Rochdale.

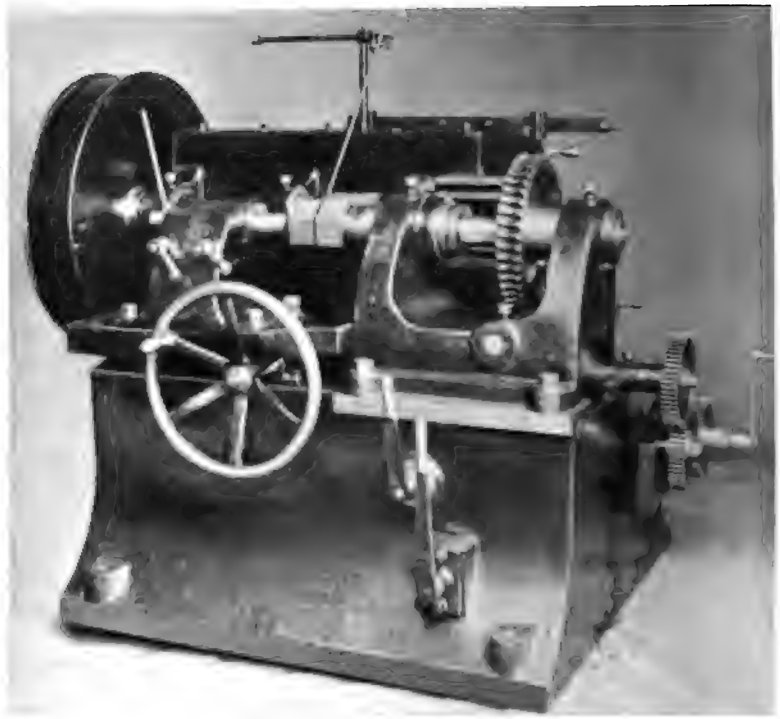


FIG. 4. HEXAGON MILLING MACHINE.

The first of the two refuse destructors erected by Messrs. Meldrum Bros., Ltd., for the city of Johannesburg is now being started to work and the second will be speedily completed. The company are putting down plants at the present time for the following towns: Preston, Holyhead, Watford, Epsom, Ayr, Hyde, Kettering, Glasgow, Todmorden, Ossett, Manchester Corporation, Barnes, Walthamstow, etc. These will furnish power for electric lighting, traction, sewage pumping and other municipal purposes.

The British Westinghouse Electric and Manufacturing Company, Ltd., are supplying two gas engines and auxiliaries to the Tiverton Corporation, through Messrs. Frank Suter and Co., of Berners Street, W. These engines are of 125 b.h.p. each, and are of the three-cylinder (15 in. by 14 in.) type. The Chesterfield Corporation have recently ordered from the Westinghouse Company a new 400-kilowatt steam dynamo, together with switchboard and auxiliary apparatus, a Babcock and Wilcox boiler and a Worthington jet condenser.

Messrs. Thomas Piggott and Co., Ltd., Atlas Works, Birmingham, inform us that they have removed their London offices from 14, Great St. Thomas Apostle to 63, Queen Victoria Street.

An order has lately been placed by the General Electric Company, of the United States, with Messrs. Mather and Platt, Ltd., for fourteen of their special type centrifugal pumps for high lifts. These pumps will be driven by General Electric Company motors connected through a flexible coupling, and are intended for use in two gold mines in India; six pumps will be connected in series in each mine; the seventh being a spare.

The Stirling Company, of U.S.A., advise us that they have now opened a London office at 53, Victoria Street, Westminster, S.W., to enable them to deal more efficiently with their London and South of England business. This office will be under the charge of Mr. G. Graham. The head office of the company will be at 53, Deansgate Arcade, Manchester, as heretofore.

JAPANESE ARTILLERY IN ACTION.
Covering an advance.

THE WAR BETWEEN RUSSIA AND JAPAN.

BY

N. I. D.

In view of the concentration of interest upon events in the Far East, our naval correspondent is confining his attention this month to the war. His remarks cover the period between the commencement of hostilities and February 24th. For many of the illustrations we are indebted to *The King and His Navy and Army*.—Ed.

WITH dramatic suddenness the negotiations between Russia and Japan with reference to the irrespective positions in the Far East, were broken off at the beginning of last month; but with even more dramatic suddenness did the Japanese readjust the balance of naval power which for some months has been slowly but surely tending to Russia's favour.

With the diplomatic side of the question I am not here concerned. For an understanding of the situation it is merely necessary to bear in mind the disposition of the forces of the combatants in the early days of February. It was on the 5th of that month that the Mikado's Government intimated to St. Petersburg that, their patience being exhausted, they must terminate negotiations with words, and appeal to the sword. It has since been learned that on or about that day the Japanese fleet, with the exception of a few small cruisers, was ordered to assemble at Sasebo, under the command of Admiral Togo. It is believed that six battleships, the *Mikasa*, flagship, *Asahi*, *Fuji*, *Yashima*, *Shikishima*, and *Hatsuse*, with six armoured cruisers, the *Asama*, *Yakumo*, *Azuma*, *Idzumo*, *Iwate*, and *Tokiwa*, and at least eight protected cruisers with nineteen torpedo boat destroyers concentrated there.

The Russians, on the contrary, in defiance of all recognised tenets of strategy, distributed their fleet between three points, Port Arthur, Vladivostok, and Chemulpo, knowing well that in the event of war, the vessels at the northern port could hardly hope to effect a junction with those in the Yellow Sea. At Port Arthur there were gathered the seven battleships, *Retvisan*,

A GENERAL VIEW OF PORT ARTHUR.

(2,2)

Cesarevitch, *Poltava*, *Petropavlovsk*, *Sevastopol*, *Peresviet*, and *Pobieda*, with the armoured cruiser *Bayan*, and the small cruisers *Boyarin*, *Novik Askold*, *Diana*, and *Pallada*. At Vladivostok there were four powerful cruisers, the *Gromovoi*, *Rossia*,. *Rurik*, and *Bogatyr*, which could easily have left for Port Arthur at any time, as the harbour was kept clear of ice. And at Chemulpo were the cruiser *Variag*, and the old gunboat *Korietz*, neither of them of much use singly, but important integral factors in the combined fleet. It is further to be noted that for some cause or another Port Arthur has ceased to be ice free in the winter, and the whole of the Russian fleet there, with the exception of the *Sevastopol* in dock, was forced to leave the inner waters hurriedly on January 29th, to avoid being locked up in the ice then forming, and to lie outside the breakwater.

Such, then, was the position of the opposed fleets on the first day (February 6th), that a state of war may be said to have been in existence. It would be foolish to suppose that Admiral Alexeieff was unaware of the dangerous position his fleet was in. If he did not know it, at least Vice-Admiral Stark did. But no steps were taken to put the fleet in the only safe place, the open sea. Whether those responsible acted on instructions from St. Petersburg or not is never likely to be known. The result was the same. A powerful fleet was left in an exposed position, no apparent steps were taken, such as would seem to be indicated by common prudence, and the Japanese found an easy prey.

For Admiral Togo had steamed into the Yellow Sea, followed by Admiral Uriu with the armoured cruisers *Asama* and *Chiyoda*, the protected cruisers *Takachiho*, *Naniwa*, *Suma*, and *Akashi*, six torpedo boats, and several transports. It may be urged that the Japanese were strategically foolish to send out their transports before having established command of the sea. Had the two vessels at Chemulpo been a torpedo flotilla, as in the correct course of events they should have been, and had the Port Arthur fleet not remained cooped up at its moorings, the earliest engagements of the war would in all probability have made different reading. But the very daring and success of the manœuvre shows that the Japanese had not miscalculated the probable action of their opponents.

In the forenoon of February 8th, according to the Japanese official information, Admiral Uriu's squadron met the *Korietz* as she was coming out of port, at Chemulpo. The *Korietz* took up an offensive attitude, and fired upon the Japanese torpedo boats, which replied with torpedoes, none of which took effect. It is not stated that Admiral Togo's fleet was then in sight. In all probability it was not. At any rate, neither of the Russian vessels could get out to carry the news to Port Arthur, and the consequence was the *débâcle* of midnight, February 8th to 9th. It is best described in the official despatch sent by Admiral Alexeieff to the Emperor. In its very baldness it is more significant than columns of description :—

> I most respectfully inform your Majesty that at about midnight on the night between February 8th and 9th Japanese torpedo boats made a sudden attack by means of mines [torpedoes] upon the squadron in the outer roads of the fortress of Port Arthur, in which the battleships *Retvisan* and *Cesarevitch* and the cruiser *Pallada* were damaged. An inspection is being made to ascertain the character of the damage. Details are following for your Majesty.

When the details came to be known it was at once obvious that the attack had been far more successful than even the first intimation had led us to believe. The *Cesarevitch* was damaged in her steering compartment, the *Retvisan* below the water line, and her pumping gear put out of order; while the damage to the *Pallada* was amidships, "near the engines." And since, up to the time of writing, it has not been found possible to get the *Pallada* into dock, it looks very much as if that "near the engines" was to read "in the engine-room."

The following day the Japanese began a bombardment of Port Arthur, and in the course of the fight, which lasted about an hour, the battleship *Poltava* and the cruisers *Diana*, *Askold*, and *Novik* were each damaged on the water line. The Russian losses were thirteen killed and fifty-four wounded. Admiral Togo, in a dispatch, dated at sea, February 10th, states that his losses were four killed and fifty-four wounded, and the damage to the ships was slight. Subsequently, he reported the ships

(*Continued on page 251.*)

THE RUSSIAN BATTLESHIP "PERESVIET."

Displacement, 12,674 tons ; I.H.P., 14,500 ; speed, 18·5 knots ; heaviest armour, 9·5-in. ; heaviest gun, 10-in.

THE NEW RUSSIAN FIRST-CLASS BATTLESHIP "CESAREVITCH," TORPEDOED AT PORT ARTHUR BY THE JAPANESE.

Displacement, 13,100 tons ; I.H.P., 16,300 ; speed, 19 knots.

ARMOUR PROTECTION : Complete water-line belt of 10-in. armour, tapering to 4 in. at bow and stern, and to 7 in below the water. A 6-in. upper belt above reaching to main deck, tapering to 2·5 in. at ends. Turrets for heavy guns, 10-in. ; secondary turrets for 6-in. guns, 7 in. ; ammunition hoists, 5 in. ; armoured deck, 4 in. on slopes, 2 in. on flat ; conning tower, 10 in., with 5 in. tube.

ARMAMENT : Four 12-in. 40-calibre guns in pairs in turrets, one forward and one aft ; twelve 6-in. 45-calibre Q.F. guns in pairs in small turrets ; twenty 12-pounder, twenty 3-pounder, and six 1-pounder Q.F. guns, with six torpedo tubes, two submerged forward.

THE RUSSIAN BATTLESHIP "RETVISAN."

Built in Philadelphia. Length, 376 ft.; displacement, 12,700 tons; speed, 18 knots; heaviest gun, 12 in. The "Retvisan," "Cesarevitch," and "Pallada," were torpedoed in the first engagement.

THE RUSSIAN BATTLESHIP "POBIEDA."

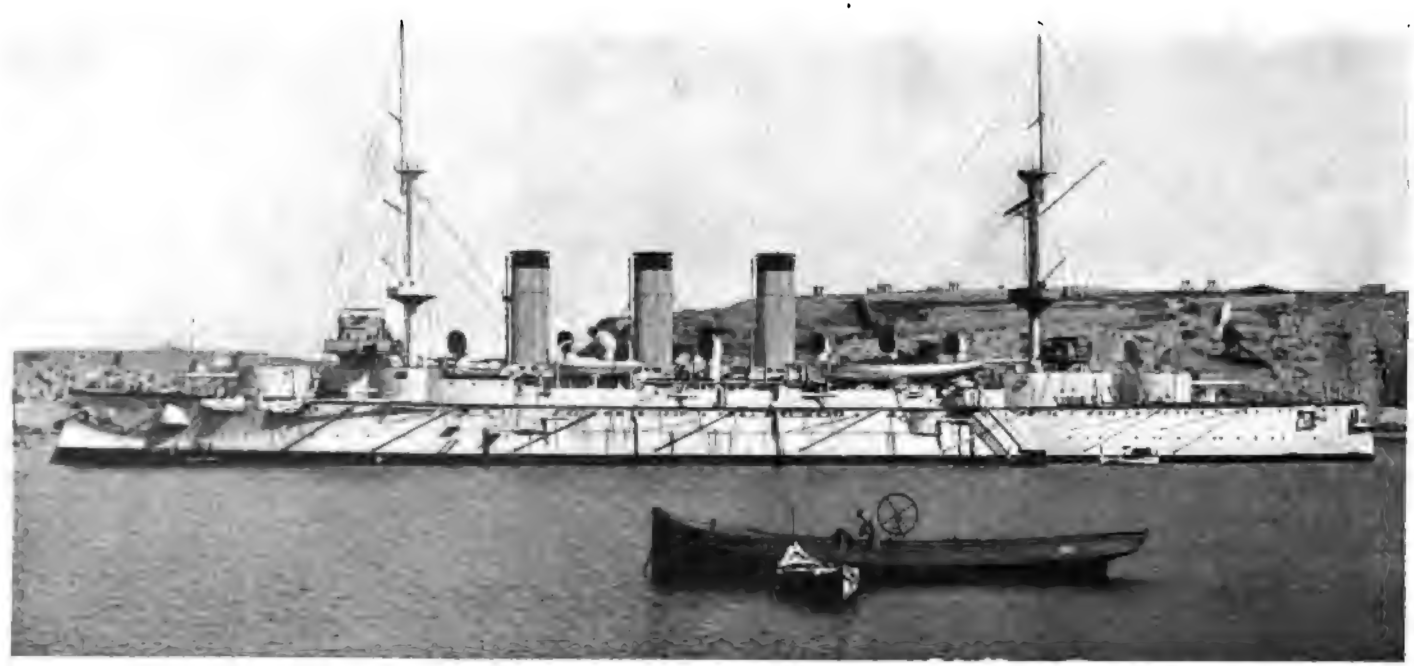
Built at St. Petersburg. Length, 435 ft.; displacement, 12,674 tons; speed, 18 knots; heaviest gun, 10 in.

THE JAPANESE ARMOURED CRUISER "ASAMA."

Displacement, 9,750 tons; heaviest gun, 8-in.; thickest armour, 7-in., I.H.P., 13,000; nominal speed, 21·5 knots. Built by Armstrong, Whitworth and Co., Ltd.

THE RUSSIAN ARMOURED CRUISER "ASKOLD."

Displacement, 6,500 tons; heaviest gun, 6 in.; nominal speed, 23 knots. Damaged on water line.



THE JAPANESE ARMOURED CRUISER "YAKUMO."

Built at Stettin in 1899. Length, 426 ft.; displacement, 9,850 tons; speed, 20 knots; heaviest gun, 8 in.

THE JAPANESE BATTLESHIP "MIKASA."

Displacement, 15,200 tons ; heaviest gun, 12-in. ; thickest armour, 14-in. ; I.H.P., 15,000 ; nominal speed, 18 knots.
[The "Mikasa" and the "Asahi," both built in British yards, may be termed the premier battleships of the Mikado's navy.]

A DETACHMENT OF RUSSIAN IRREGULARS.
Ready for service in the East.

(*Continued from p. 243.*)

damaged were the *Mikasa*, *Fuji*, *Yakumo*, and *Iwate*.

At about the same time as the bombardment of Port Arthur was proceeding, Admiral Uriu was engaging the *Variag* and *Korietz* outside Chemulpo. The result of the action was that both Russian ships returned to harbour badly damaged, where they were blown up by their crews, who escaped to the foreign vessels in the port. The Russian losses were 47 killed and 62 wounded. No casualties were reported from the Japanese side.

The torpedo flotillas which accompanied Admiral Togo were divided into two groups, one of which carried out the successful attack at Port Arthur, and the other of which appears to have gone to Dalny and drawn blank. This latter flotilla was not, however, quite deprived of an opportunity to distinguish itself, as on the night of February 14th—15th it was despatched to Port Arthur to complete the work begun six days earlier. Owing, however, to a blinding snowstorm, only two vessels succeeded in reaching the Russian Fleet, the torpedo boat destroyers *Asagiri* and the *Hayatori*. One of these succeeded in torpedoing an enemy, believed to be the *Boyarin*, but also reported to be the *Bayan*. Either way, the exploit was a remarkable one, and in no way less useful than that which heralded the war.

Of the Vladivostok squadron, it is sufficient to note that it has been cruising in the Northern Sea of Japan, sunk an unarmed merchantman on February 11th, and threatened to bombard Hakodate, an unprotected port, both of them criminal actions, which will do little to advance the progress of the war, and much to damage Russia's cause with the other powers. On February 11th also the mining transport *Yenessei* struck one of her own mines, and was blown up with great loss of life.

On February 16th, the new Japanese cruisers *Kasuga* and *Nisshin* arrived at Yokosuka, the English officers who had assisted to navigate them before war was declared, being received and decorated by the Mikado personally.

On February 24th, the important news was circulated that Admiral Virenius and the squadron which had been lying at Djibutil for some weeks was ordered home.

The effect of the action at Port Arthur on the naval situation will be better understood from a study of the following tables :—

RUSSIA—FLEET IN THE FAR EAST.

Type.	Vessel.	Date of Launch.	Displacement. Tons.	Speed. Knots.	Coal Capacity. Tons.	Principal Armament.	Weight of Broadside. lb.
b	*Peresviet*	1898					
b	*Pobieda*	1900	12,674	18·5	2,056	4 10-in., 11 6-in., 20 3-in.	2,672
b	*Ossliabia**	1898					
b	*Poltava*						
b	*Sevastopol*	1894	10,960	17·5	1,050	4 12-in., 12 6-in.	3,367
b	*Petropavlovsk*						
b	*Retvisan*	1900	12,700	18	2,000	4 12-in., 12 6-in., 20 3-in.	3,434
b	*Cesarevitch*	1901	13,100	19	1,350	4 12-in., 12 6-in., 20 3-in.	3,516
a.c.	*Bayan*	1899	7,800	22	1,100	2 8-in., 18 6-in., 20 3-in.	952
a.c.	*Gromoboi*	1899	12,336	20	2,500	4 8-in., 16 6-in., 20 3-in.	1,197
a.c.	*Rossia*	1896	12,200	20	2,500	4 8-in., 16 6-in.	1,348
a.c.	*Rurik*	1892	10,940	18	2,000	4 8-in., 16 6-in., 6 4·7-in.	1,345
a.c.	*Dmitri Douskio*	1883	5,893	15	400	5 6-in., 6 4·7-in.	444
p.c.	*Askold*	1900	6,500	23	1,100	12 6-in., 12 3-in.	772
	Variag	1899	6,500	23	1,250	12 6-in., 12 3-in.	510
p.c.	*Pallada*						
p.c.	*Diana*	1899-00	6,630	20	1,430	8 6-in., 22 3-in.	632
p.c.	*Aurora**						
p.c.	*Boyarin*	1901	3,200	22	650	6 4·7-in.	180
p.c.	*Novik*	1900	3,000	25	600	6 4·7-in.	180
p.c.	*Bogatyr*	1901	6,750	23	1,430	12 6-in., 12 3-in.	872

* On passage out.

JAPAN—FLEET IN THE FAR EAST.

Type.	Vessel.	Date of Launch.	Displacement. Tons.	Speed. Knots.	Coal Capacity. Tons.	Principal Armament.	Weight of Broadside. lb.
b	*Hatsuse*						
b	*Asahi*	1899	15,000	18	1,400	4 12-in., 14 6-in., 20 3-in...	4,240
b	*Shikishima*						
b	*Mikasa*	1900	15,200	18	1,500	4 12-in., 14 6-in., 20 3-in...	4,250
b	*Yashima*	1896	12,300	18	1,100	4 12-in., 10 6-in., 20 3-in...	4,000
b	*Fuji*						
a.c.	*Tokiwa*	1898	9,750	21·5	1,200	4 8-in., 14 6-in., 12 3-in.	3,568
a.c.	*Asama*						
a.c.	*Yakumo*	1899	9,850	20	1,100	4 8-in., 12 6-in., 12 3-in.	3,368
a.c.	*Azuma*	1899	9,436	21	—	4 8-in., 12 6-in., 12 3-in.	3,368
a.c.	*Idzumo*	1899–00	9,800	24·7	1,600	4 8-in., 14 6-in., 12 3-in.	3,568
a.c.	*Iwate*						
p.c.	*Takasago*	1897	4,300	24	1,000	2 8-in., 10 4·7-in., 12 3-in.	800
p.c.	*Kasagi*	1897–98	4,784	22·5	1,000	2 8-in., 10 4·7-in., 12 3-in.	800
p.c.	*Chitose*						
p.c.	*Itsukushima*						
p.c.	*Hashidate*	1890–91	4,277	16·7	400	11 2·5-in., 11 4·7-in.	1,260
p.c.	*Matsushima*						
p.c.	*Naniwa*	1885	3,727	17·8	800	2 10·2-in., 6 5·9-in.	1,196
p.c.	*Takichiho*						
p.c.	*Yashima*	1892	4,180	23	1,000	4 6-in., 8 4·7-in.	780
p.c.	*Akitsushima*	1892	3,150	19	—	4 6-in., 6 4·7-in.	780
p.c.	*Niitaka*	1902	3,420	20	600	6 6-in.	920
p.c.	*Tsushima*						
p.c.	*Suma*	1895	2,700	20	200	2 6-in., 6 4·7-in.	385
p.c.	*Akashi*						

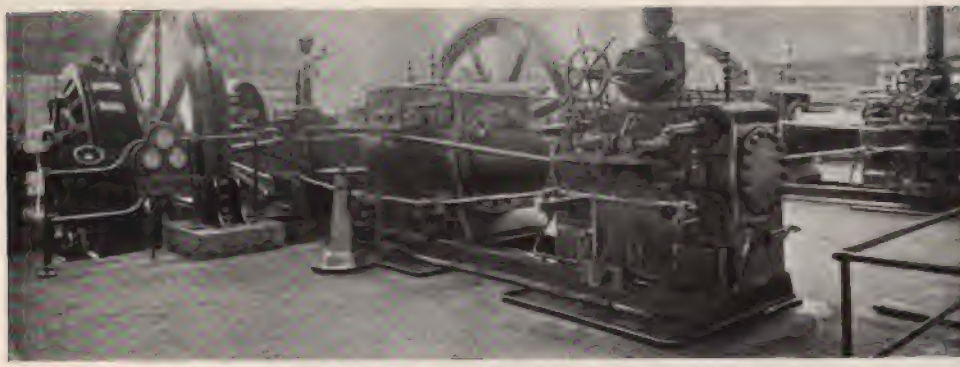
The immediate effect of the reverse to the Russians in the Far East was to set rumour active with regard to the Baltic and Black Sea fleets. The Black Sea fleet, it is quite permissible to leave altogether out of consideration in reference to the situation in the Far East. For not only are the vessels too old to be of much use out there, they are also of too small coal capacity to render it practicable to send them on the journey, even could permission be obtained to let them pass the Dardanelles. Much the same objection applies to the Baltic fleet, as will be seen from the following table:—

RUSSIA—FLEET IN THE BALTIC.

Type.	Vessel.	Date of Launch.	Displacement Tons.	Speed. Knots.	Coal Capacity. Tons.	Principal Armament.	Weight of Broadside. lb.
b	*Sissoi Veliky*	1894	8,800	16	800	4 12-in., 6 6-in.	3,099
b	*Navarin*	1891	9,476	16	1,000	4 12-in., 8 6-in.	3,172
b	*Nicolai I.*	1889	9,700	15·9	1,200	2 12-in., 4 9-in., 8 6-in.	2,292
b	*Alexander II.*	1889	9,900	16·5	1,200	2 12-in., 4 9-in., 8 6-in.	2,292
b	*Borodino*						
b	*Alexander III.*						
b	*Orel*	1901–02*	13,516	18	1,250	4 12-in., 12 6-in., 20 3-in.	3,456
b	*Kniaz Suvaroff*						
b	*Slava*						

* These vessels are completing, and will not be ready to leave till the late spring.

In all these tabular statements I have only taken into account the larger vessels. Small craft would be practically useless for the Russian purpose out there, even if they could get there, which is more than doubtful.



PART OF THE GENERATING PLANT. BATH TRAMWAYS.

THE BATH TRAMWAYS.

A Description of the System, with a Brief Account of the Inauguration.

By A STAFF CORRESPONDENT.

A SMALL enclosed area — a mere nucleus within an arm of the River Avon — represented the Aqua Sulis of the Romans. Modern Bath is an altogether different affair. Since the time of Beau Nash, whose visitors arrived in stage coaches, the city has steadily encroached upon its beautiful surroundings, until picturesque Bathford, on the extreme east, seems anxious to join hands with the residential suburb of Weston, and the more industrial district of Twerton on the other side of the map. Thanks to the new tramways, this has actually come to pass.

The site of the City is said to be of volcanic origin, and, as is well known, lies in a hollow, the springs rising in the heart of the city within a few yards of

CAR SHED AND OFFICE BUILDINGS.

NEW TRAMS PASSING THE GUILDHALL. BATH ABBEY IN THE BACKGROUND.

The car shown in the foreground has to encounter some difficult gradients, its destination being the heights of Combe Down.

routes being 12½ miles. The gauge is the standard 4 ft. 8½ in. The steepest gradient is 1 in 11, and is 4 chains long, there being also five short lengths of 1 in 12; the worst gradient, however, is 1 in 14, 18 chains long. The sharpest curve is 37 ft. radius, and there are four less than 40 ft., and ten less than 50 ft. Four routes radiate from the centre of the city, two of them with short spurs, and one with an elongated loop. The construction of another mile of route is authorised, and will go to form two loops in the city itself.

The buildings are situated on the banks of the Avon, and consist of a boiler-house, engine-house, and car-shed. They are similar in character to those of the power station erected by the British Westinghouse Company for the working of the Mersey Railway. The boiler-house is 93 ft. long and 49 ft. wide; the engine and generator house being the same length, but 2 ft. wider. The car-shed is about 130 ft. long and 82 ft. wide. Over the street end of the car shed are various rooms for offices etc., while at the rear end is a large basement which is used as a repair shop. Eight tracks run the full length of the shed, an inspection and repair pit 30 ft. long being built in each track. The walls of the building are of brick. The engine room walls inside are of glazed brick to a height of 10 ft. and the roof trusses and the purlins for slating are entirely of steel. The iron and steel constructional work was done by Messrs. Lysaght and Co., and the glazing by Messrs. Mellowes, as sub-contractors to the British Westinghouse Company.

The engine foundations extend some 25 ft. to 30 ft. below the floor of the engine room, the floor being of concrete finished with cement. The chimney shaft is 140 ft. high, 13 ft. 6 in. diameter at base, and 7 ft. in diameter at the top under the cap. It is of sheet steel, lined inside with brick to a height of 60 ft., and was built by the British Westinghouse Company. The chimney rests on a bed of concrete and brickwork. Though self-supporting, it is held down by bolts as an extra precaution, and is fitted with a permanent ladder.

THE STEAM PLANT.

This comprises three Babcock and Wilcox boilers, each with a heating surface of 3,140 square feet, making a total of 9,420 square feet; and each boiler is normally capable of evaporating 11,000 lbs. of water per hour, with a maximum of 13,000 lbs. per hour, the working steam pressure being 160 lbs. per square inch. The grate area per boiler is 59½ square feet. The tubes are 4 in. diameter and 18 ft. long, and are arranged in four sections of ten. Each boiler is fitted with a superheater having 339 square feet of heating surface, this being sufficient to allow of the steam produced by the boiler receiving a superheat of from 100° to 120° F. After erection the boilers and superheaters were tested under an hydraulic pressure of 240 lbs. per square inch. The boiler mountings are by Dewrance.

The superheater consists of 48 solid drawn steel tubes 1½ in. diameter, and suitable piping and cocks are provided for flooding it when necessary. The guaranteed efficiency of each boiler and superheater is: 68 per cent. at maximum load, 70 per cent. at full load, 70 at three-quarter load, and 68 at half-load. About 10,800 firebricks and 37,500 ordinary bricks were required for setting the three boilers.

The economiser consists of 240 9-ft. tubes, and is of the Claycross type. The feed water can be taken either from the river Avon or from the town mains. The scrapers have overlapping joints and chilled edges, and are driven by an electric motor.

There are two feed pumps, one steam and one electrically driven. The former is by Messrs. J. P. Hall and Son, is of their vertical slow-speed type, and was supplied by Messrs. S. Sugden, Ltd.; the latter is a Blake and Knowles three-throw pump, and is driven by a Westinghouse direct-current motor. The Hall pump is capable of delivering from 30 to 45 gallons of water per minute with a steam pressure of 150 lbs. per square inch and 100° F. superheat against the boiler working pressure of 160 lbs. The guaranteed delivery per 1 lb. of steam at normal, three-quarters, and half-load is 72, 66 and 59 lbs. of water respectively. The Blake and Knowles pump has cylinders 5 in. diameter with 6 in. stroke, and can drive 2,700 gallons of water per hour against the boiler pressure when running at 40 revolutions per minute. This pump does not absorb more than 8·5 b.h.p. from the motor at full load, 7 b.h.p. at three-quarter load, and 5 b.h.p. at half-load.

There are also two make-up pumps by Blake and Knowles, each of these having a capacity of 300 gallons per hour.

The two surface condensers by the Wheeler Condenser and Engineering Company, Ltd., have a combined cooling surface of 2,820 square feet, and are together capable of dealing with 28,000 lbs. of exhaust steam per hour at normal load, and 35,000 lbs. for one hour as a maximum, the circulating water being obtained from the adjacent river Avon. The brass tubes are ⅝ in. diameter, 18 B.W.G. thick, and seamless drawn and tinned inside and out. Two Wheeler combined air and circulating pumps were supplied by Messrs. Fraser and Chalmers, Ltd. The steam cylinder is 12 in. diameter, and the air and circulating cylinders 14 in. diameter, the stroke being 12 in. The condensed water cylinder is 3½ in. in diameter and the stroke 12 in. The whole of the piping for the steam exhaust, feed and circulating water was supplied by the Sir Hiram Maxim Electrical and Engineering Company.

A Holly steam-loop and gravity system is installed for taking care of the high-pressure drains, this being entirely automatic in its action, and free from all moving parts. In this system the water of condensation in the steam pipes is carried by gravity into a small receiver 5 ft. long and 12 in. diameter, placed at the lowest point in the piping system; from which it is forced by means of a steam jet into a receiving chamber situated in the roof of the boiler-house. From this chamber it returns by hydrostatic head into the boilers, the water returning practically all its heat thereto. The system is continuous in operation, and there are no moving parts. The water softener and purifier are by Masson, Scott and Co. The former has a capacity of 300 gallons of water per hour, and the purifier a capacity of 1,250 gallons per hour.

The major portion of the oil is first removed by the Holden and Brooke extractor mentioned below, and the

Masson and Scott purifier then removes the emulsified oil as well as all oil remaining in suspension, and produces a thoroughly pure water for boiler feed purposes.

The main steam piping is 12 in. diameter, and the branches 6 in., with 3-in. pipes to the pumps. The system is fitted with Hopkinson valves, and was supplied and fixed by the Sir Hiram Maxim Electrical and Engineering Company.

The Holden and Brooke grease extractor is capable of dealing with 1,500 gallons of condensed water per hour and is fitted in the main exhaust pipe, and the latter then passes on to the two surface condensers. An automatic relief valve is fitted, and for the purpose of exhausting to atmosphere, a galvanised iron pipe, 14 in. diameter, leads up through the boiler-house roof. The main exhaust piping is 16 in. diameter, with 11 in. diameter branches to the engines.

COAL-CONVEYING PLANT.

The coal is carried straight from the railway trucks to the storage bins by "screw" conveyors made by the Conveyor and Elevator Company of Accrington. The bins have a capacity of 50 tons. A spiral coal-conveyor brings the coal from the storage to the front of each boiler fire-grate. This can deal with 10 tons per hour when running at 30 revolutions. The trough is 14 in. diameter and $3\frac{1}{16}$ in. thick, with coal outlets 9 in. square; the spindle being $2\frac{1}{2}$ in. diameter, and driven by a Westinghouse motor.

ELECTRIC CRANE.

The Westinghouse Company also supplied a three-motor electric crane, and erected the same in the engine-room. It is a Stothert and Pitt 15-ton overhead electric traveller with a 50-ft. span, and traverses the entire length of the engine-room.

THE ENGINES.

The three Yates and Thom horizontal, tandem, single-crank, compound, condensing engines have cylinders 15 in. by 30 in. diameter and 36-in. stroke, and Corliss valves. They are of 320 h.p. each, and are capable of driving the 200 kilowatt generators continuously at full load with 160 lb. of steam; at 25 per cent. overload for half an hour; and at 50 per cent. overload momentarily. The engines give this output under both condensing and non-condensing conditions; the efficiency of the generators being taken as 93 per cent. The Corliss valves are worked by trip gear of the Dobson pattern, and the centre-weight governor with cross-arm is such as to keep the speed constant within 2 per cent. A sensitive knock-off appliance is fitted to the governor, the purpose of which is to disconnect the trippers and hold them in such a position as to cut off the admission of steam to the cylinder. This action takes place should the engine from any untoward cause attain an excessive speed, or should an accident happen to the governing gear.

The crank shaft of each engine is of mild forged Siemens steel, and is 16 in. diameter at the flywheel and 14 in. diameter at the bearings. The flywheel of each is 16 ft. in diameter, and weighs 18 tons. Under condensing conditions, and with the steam at 100° F. superheat, the steam consumption at full, three-quarters, and half-load does not exceed $15\frac{1}{4}$, $15\frac{3}{4}$, and 17 lb. per horse-power-hour respectively.

GENERATING PLANT.

The three 200-kilowatt Westinghouse direct-current traction generators are eight-pole machines, and develop a pressure of 500-550 volts; the armatures being pressed on to the engine shafts. The armatures are of the slotted drum type, with two circuit windings so arranged that the circuit will not become unbalanced by a displacement of $\frac{1}{16}$ in. from the geometric centre of the fields. The windings are arranged to give 500 volts at no load and to over-compound to 550 volts, with a full load of 365 amperes. The insulation of both armature and field-coils is flashed with an alternating pressure of 3,500 volts.

The generators are capable of standing an overload of 25 per cent. for half an hour; and one of 50 per cent. for short periods. With a full load run of one hour the temperature rise did not exceed 40° C. above the surrounding air; while with half an hour's run at 25 per cent. overload, the rise did not exceed 50°C. At full, three-quarters, half, and quarter-load the efficiency works out at 93, 92·5, 91·5, and 88 per cent. respectively. Each of the machines was submitted to the following special test: With the no-load voltage adjusted to 500 a load of 547 amperes (with such increase of voltage as was maintained owing to the combined series and shunt excitation) was put on to the machine for a short time; the main circuit was then suddenly opened, but the machine did not "buck," neither did any serious sparking occur.

The 75 kilowatt lighting and auxiliary traction set comprises a Westinghouse high-speed vertical, enclosed, two-cylinder, single-acting, compound engine, and a Westinghouse traction generator. The high and low-pressure cylinders of the engine are 11 in. and 19 in. diameter respectively, and the stroke 11 in. The generator is a four-pole 75-kilowatt D.C. machine, developing some 150 amperes at from 500 to 550 volts, the set running at 300 revolutions per minute.

The two 15-kilowatt Westinghouse boosters are 4-pole machines running at 575 revolutions per minute, the motor volts being 500 and the booster volts 50.

MAIN SWITCHBOARD.

The main switchboard is of the standard British Westinghouse traction type, with white marble panels two inches thick set in an angle-iron frame. There are thirteen panels altogether, the purpose of these being as follows: One each for the three large traction generators; one for the lighting set; one station-load panel; one B. of T. panel; one each for the two booster sets; one for the station lighting panel; one for the yard and car-shed lighting; two for positive feeders; and one for the negative main.

The various instruments are of the British Westinghouse types, and include a combined bus-bar and paralleling voltmeter mounted on a swinging bracket.

THE TRACK AND FEEDER CABLES.

Mr. Charles Chadwell, of 20, Victoria Street, S.W., undertook the laying and equipment of the track and the feeder cables; the rails, fish-plates, bolts, and nuts, being supplied by the North Eastern Steel Company, of Middlesbrough.

The rails are cross-bonded every 33 yards, the bonds being "Crown" 4/0 B. and S. gauge with ⅞-in. nipples. These were supplied by the American Steel and Wire Company.

The points are 8 ft. 6 in. and 12 ft. long, and are chiefly of Hadfield's Patent Manganese steel, some of them being supplied by the Lorain Steel Company. The crossings were supplied, and the special track-work done, partly by Hadfields and partly by the Lorain Steel Company.

OVERHEAD EQUIPMENT.

The overhead line is mostly supported on brackets (varying from 6 ft. to 22 ft. in length) on side poles; but in some parts of the city span wires with supporting rosettes are stretched from the fronts of the houses. The latter were supplied by Messrs. Stuart and Lloyd, and the pole bases by Messrs. Wm. Bain and Co. The poles are in three pieces, and stand 24 ft. high over all. There is no centre-pole construction. The trolley wire was supplied by Messrs. Fredk. Smith and Co., Manchester, and is of hard-drawn copper 2/0 B. and S. gauge (·364 in. diameter), this being practically equivalent to 3/0 S.W.G. size.

The guard wires are of galvanised steel in strands, 7/12, 7/14 and 7/15; the manufacturers bein Messrs. Richard Johnson and Nephew. These are earthed through the poles, every third one of which (in the guard wire sections) is bonded to the rails.

The cars are of the ordinary type, and both mechanical and trailing frogs are used. The cars were obtained from the Electric Tramway Equipment Company, who also supplied some of the frogs, the remainder of the latter being manufactured by Messrs. Brecknell, Munro and Rogers. The average length of the sections is half-a-mile, some of the section boxes containing feeder pillars, and one of them a Board of Trade panel in accordance with the regulations. These boxes were supplied by the British Thomson-Houston Company, Ltd.

The distributing system comprises some seven and three-quarter miles of paper-insulated and lead-covered cables by the British Insulated and Helsby Cables, Ltd. They are laid partly solid and partly in porcelain ducts. There are 270 yards of ·2 square inch; 4,700 yards of ·25 square inch, and 6,700 yards of ·3 square inch section. The return cables have a section of ·6 square inch, and total up to 1,760 yards. There are over 6,700 yards of 3-core, 4-core, 6-core, and 7-core 7/22 pilot wires; and some 8¼ miles of overhead telephone and test wires, all this work being done by Mr. Charles Chadwell.

THE CARS.

Of the thirty cars that are so far running, 26 are double-deckers and 4 single-deck combination cars, all of these being of Milnes construction. There is also one watering car. The double-deckers measure 27 ft. in length over collision fenders, and the single-deckers 28 ft. The trucks are of Milnes S.B. 60 4-wheel type, the wheel base being 6 ft.; the wheels and axles being supplied by the British Griffin Company. The stairways are of the ordinary pattern, and the Milnes type of life guard is fitted to each car. The trolleys have swivel heads with graphite brushes, and were made by Messrs. Brecknell, Munro and Rogers. The destination signs are of the British Electric Car Company's pattern, and were supplied by Messrs. Milnes. The cars are nicely upholstered, and are lighted both inside and outside. The British Westinghouse Company carried out the electrical equipment of the cars; each being fitted with two 49 B-type 30 h.p. motors, and No. 90 controllers, as well as with the British Westinghouse Patent Magnetic Brake. There are also hand brakes.

The severe gradients and curves on the Bath system (the maximum gradient being 1 in 11) have put the Westinghouse (Newell) magnetic brake, with which all the cars are fitted, to a severe test. This brake, by the way, is the only one which has received the approval of the Board of Trade, one of its leading features being that it will, with the controller handle in the breaking position, automatically bring the car to rest on the steepest incline should the trolley leave the wire.

THE LUNCHEON.

At the luncheon Sir Vincent Caillard was supported on the right by Lady Sivewright, the Mayor (Major C. H. Simpson), Lady Caillard Mr. Henry Milton, Mrs. Hugh Clutterbuck, Mr. G. Woodiwiss, D.L., Mr. Swinton, Mr. Silcock, Mr. Donald Maclean, Mr. Hopkins, the Town Clerk, Mr. W. Pitt, and Mr. Crisp, and on the left by Lady Fairbairn, Sir James Sivewright, Mrs. Caillard, the Rector of Bath, Col. H. F. Clutterbuck, Mr. Lukach, Alderman Phillips, Mr. Trenow, Mr. W. S. Brymer, Mr. Huxtable, Mr. Harper, Mr. Oliver Shiras, and Mr. McCarter, while Aldermen Rubie, Taylor, Moger, Chaffin, and Stone presided at the other tables. There was a large and influential gathering.

The Mayor, proposing the toast of "Prosperity to the Bath Electric Tramways, Ltd.," claimed that wherever electric trams had gone prosperity had followed. It was satisfactory to know that the Bath Company had had as good, if not a better start than similar tramways in other parts of the kingdom. The trams, while they would not inconvenience carriage folk to the extent many supposed, would further extend the frontier—as it might be called—of the city, and if ratepayers were taken away it was certain they would be brought back to spend money in the city. With regard to the power station, it would be wrong for him to sit down without expressing the appreciation of Bath and its citizens on the way in which it had been constructed. In the shortest possible space of time a gigantic work had been done, and those who inspected it that day could not but have been astonished at what had been done there. To Mr. McCarter (applause) and those who had worked with him they accorded their best thanks (applause).

Sir Vincent Caillard responded, and in the course of an excellent speech recognised the cordial, energetic,

and efficient assistance which, from the very outset, they had received from Sir James Sivewright. While on this topic he would like to add, for his co-directors, that he thought they had as efficient and as small a Board as any tramway company in the kingdom. efficiency was a great thing and be believed it was well promoted by smallness. (Hear, hear.) He would also like to take that first public opportunity of recognising the most excellent solid work which their engineers—Messrs. Hopkins and Harper—had put into that undertaking, and he could not pass away from that part of the undertaking without mentioning the contractors—the Westinghouse Company—whose magnificent work at the power station they had seen, and Mr. Chadwell, who was responsible for the overhead and the roadwork. After a humorous reference to certain little tiffs with the Corporation, which had, he thought, served to draw them still closer together, he remarked that the exceedingly good start to which the Mayor had drawn attention had been made under difficult circumstances. Their power house was not ready; they had not even now got the number of cars they had ordered, and therefore the possibilities of traffic and the convenience of the public had not been developed nearly so far as they would be. The future which was assured to the tramways was evidently so prosperous that they might almost take the good wishes they had extended in drinking that toast, as fulfilled. It only remained for him to thank the whole of the public of Bath for the fine welcome they had given to the tramways, as had been proved by the use they had made of them, and to thank the company for the way they had received the toast.

Sir James Sivewright, in felicitous terms, gave "Prosperity to the City of Bath." Referring incidentally to the discovery of radium in the deposits of the Bath mineral waters. He was glad that the responsibilities of chairman had been taken over by a gentleman so well qualified to occupy the position, and one so well known in the West as Sir Vincent Caillard. (Applause.) He knew of no tramway company with a stronger Board. There was Mr. Hugh Clutterbuck (applause), whose life had been made a burden to him by the citizens during the installing of the system, and Mr. Swinburne, a man whose name was a household word in matters connected with electricity. He was also glad to find the citizens of Bath had recognised already the sterling worth of their manager, Mr. R. D. McCarter. Their engineers had done excellent work, but after all it was to the general manager that the public looked, as well as the sharedolders, for in such a public undertaking it was right that every possible consideration should be, as far as possible, shown to the public, consistently with the interests of the undertaking. There was also Mr. Trenow, secretary of the company, who, in deference to the wishes of the Board, had joined the Board as managing director. In drinking "Prosperity to the City of Bath," they who were connected with the company recognised that they were drinking to the company's prosperity also. (Hear, hear.) He wanted them to bear in mind that the prosperity of Bath and the prosperity of the trams were linked up now for better or worse, so long as the company was in existence. Whatever was to the advantage of the one was to the advantage of the other, and as one who had a large stake in the company, and who meant to retain it, remembering that they never looked for bloated dividends, but only to enjoy a fair rate of interest, he had the utmost confidence in giving "Prosperity to the City of Bath." (Applause.)

The Mayor, in the course of a brief reply, referred to the important work which had been done by Alderman Taylor, on behalf of the Corporation, in bringing the negotiations to a satisfactory termination.

A few remarks from Alderman Taylor followed. He believed the trams had come there not only to stay but also to pay. As far as he and his committee were concerned, they were perfectly satisfied with the transactions they had had with the company, and their friend, Sir James Sivewright. (Applause.) The system was quick, cheap and safe. (Applause.) That the trams were fully appreciated was shown by the fact that during a single week they had carried double the population of the City. (Applause.)

CONGRATULATIONS.

In conclusion, we may congratulate the engineers (Messrs. George Hopkins and Son, Messrs. Harper Bros. and Co., and Mr. R. D. McCarter) and the contractors (Mr. Charles Chadwell and the British Westinghouse Electric and Manufacturing Company) upon the quick completion of their work; great credit being also due to Mr. R. D. McCarter for the efficient way in which he superintended the erection and equipment of the generating station, etc., and also for his successful inauguration of the duties of management.

PAGE'S MAGAZINE

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OUR MONTHLY SUMMARY.

LONDON, February 22nd, 1904.

The War.

We have heard enthusiasts express longing for a great naval European war in order that the strength or weakness of specific battleship construction might be demonstrated. The historic engagements of the past month have deprived them of all excuse, and at the same time have furnished our Naval experts with some valuable data. Whatever may be our opinions as to the *casus belli*, every Englishman must feel a sense of satisfaction in knowing that the Japanese navy is almost entirely of British construction. It seems scarcely credible that prior to 1859 the Japanese fleet consisted of a number of junks and one or two ships built from Dutch designs of the seventeenth century. Japan's splendid navy is a standing monument to her enterprise, and her audacity in attack shows that the personnel of a modern navy is a factor of no less importance than it was in the days of Queen Elizabeth. The war is specially dealt with in this number by our naval Correspondent.

Problems for the Engineer.

In the course of his presidential address to the Manchester Association of Engineers, Mr. Alfred Saxon dealt with the forces that have gone to make up what he termed an engineering revolution. The conclusion of the address was concerned with the future of the mechanical engineer and the problems he will have to face "On what lines," he asked, "might they expect this engineering revolution to continue?" The demand for producing electricity cheaply for power and lighting; the demand for the cheapening of manufactured goods and articles of all descriptions; the shortening of the time occupied in ocean voyages; the development of aerial navigation; the demand for carriage of goods and merchandise at a lower cost, and amongst the problems of our city life the demand for cheap and rapid transit to and from the suburbs. They had also to consider the problem of the reduction in the losses which existed in power installations, and the reduction of the inertia and frictional losses in all kinds of machinery and machine tools, the existence of which to so considerable an extent had been revealed by electric driving. There was also the reduction of losses occurring in the transmission of power, and generally their aim should be to increase the amount of useful work done in proportion to the total power expended. New sources of power were being introduced from time to time, and practically tested; other sources were being suggested, and so active was recent mechanical and chemical research that they had amongst other discoveries the marvels of radium to add to the list. They had inferior coals, oil, peat, vegetable mud, natural gases, and the utilisation of other substances which had hitherto been looked upon as waste materials to augment their coal supplies, and there was no doubt that they have other natural resources hidden which had not yet been tapped, and which would repay their greatest efforts to discover. The future of engineering was bright with possibilities, and there were those who saw in means of increased production and improved facilities of transport a time when the working days would be shortened, but if these dreams were to be realised, engineers must not in their work choose the path of least resistance, but must tackle in their

day and generation the problems that arose. The country was no doubt at a disadvantage with many other countries in the generation of electricity in the cheapest manner by water turbines. Therefore from a national point of view, economies were absolutely necessary if they were to conserve that form of energy contained in coal supplies, which had hitherto helped them in the industrial race.

Employment in 1903.

The Board of Trade returns regarding employment last year do not make very cheerful reading. It requires no extreme of optimism to predict a better state of things next year, for 1903 showed a falling off compared with the three years immediately preceding and was not up to the level of an "average year." The mean percentage of unemployed returned by Trade Unions during 1903 was 5·1, compared with 4·4 in 1902, 3·8 in 1901, 2·9 in 1900 (a year of exceptionally active employment), and 2·4 in 1899. The average percentage for the ten years 1894 to 1903, was 4·1. The falling off in 1903, as compared with 1902, was marked in the latter half of the year. There has been a continuation of the decline in demand for labour in the building trades which has been going on since 1900. Shipbuilding was acutely depressed in 1903 by a lessened demand for new ships (connected with the low level of freights during the last three years) and at the present time, there is a high percentage of workpeople unemployed in this trade. The trades (*e.g.*, steel) which supply the shipbuilders with materials were also affected adversely Employment for coal miners, as shown by the average weekly numbers of days worked by coal pits, was less active in 1903 than in any year since 1896.

On the other hand, employment in 1903 was fairly good in certain industries, and among these may be mentioned iron mining and tinplate manufacture.

The British Workman and Cousin Jonathan.

While on the subject of employment, we are reminded of some interesting comparisons which have been lately made between the general conditions here and in the shops of America. For instance. "W. H." in "The Mechanical World" says that a return to England after a few years in America is very relaxing. One wonders comparatively what English workmen have to complain about. Why don't they do a reasonable amount during the few hours they are at it? Their pay is little enough, certainly, but it is not as well earned as the American's extra money. It makes one feel uneasy regarding England's future to see that the prevailing spirit is to give as little work as possible in return for wages paid. "W. H." quite understands the altruistic spirit which is largely the cause of it; but looked at from an international standpoint, it is like one-sided free trade. You don't find it in American shops to any appreciable extent. The difference cannot be accounted for on the ground that the American is paid better, and treated better. The English workman, generally speaking, is treated as he wants to be treated, and has the conditions that suit him. Conditions that are entirely against his tastes cannot be imposed on him. Personally, continues "W. H." I prefer English conditions to American—with the exception of wages, of course; but I should like to see English shops make for more freedom and equality between men on different lines from those prevailing in America, though in some respects America might well be followed.

Comfortable working conditions is a thing we pay little attention to. The American works under the best conditions he can get. In the course of further observations he remarks that there is only one thing wanting in America, and that is a superior class of men to correspond with the superior material conditions. This America has not yet got.

The "Ideal" Employer.

Having glanced with "W. H." at the respective conditions of English and American workmen, let us devote a minute or two to the "ideal" employer from an American point of view. If the reader has a large perceptive mind, if he can see a dozen different objects at one time while engaged in conversation on another subject, and can answer questions mechanically yet correctly, he fulfils the first condition laid down as necessary for the ideal employer, by Mr. R. A. Baker, in a paper contributed to the Cincinnati Metal Trades' Association. We are rather inclined to think that such a person would prove somewhat irritating, as his fits of abstraction might not be confined to the workroom—so perhaps it is just as well that he is only ideal. The author goes on to say that he should possess great intellect, be broad in his views, both kind and just, ever ready to mete out scorn or praise, wherever the call, whether friend or foe, relative or stranger. Let the ideal employer create an incentive for better work, show the employee where he is weak, have experts go over all details ot be produced, devise means, jigs and charts, and positive instructions how to produce each part as economically as possible, mechanically true and correct. Post these instructions where the men can view and study them. Stir their brains to activity and success will be your reward. The ideal employer should not permit himself to allow the shop management to become a strictly family affair or be made up of influential friends and deadheads regardless of merit and ambition. He should be a born leader of men, of sweeping influence, easy of approach, capable of condescending to a friendly word for this or that employee, without endangering their respect for him. He should very thoroughly and carefully look after the general health and welfare of his employees, and must pursue a policy along friendly and co-operative lines. Bring business methods into their work, says the author, and they will realise the trust confided in them in handling your dollars.

Radium—Some Misconceptions.

An American contemporary reminds us that in nearly all the popular articles and many scientific ones, radium is a word used to denote not the metal of that name, but its chloride or bromide, generally the latter. In a similar slipshod fashion the photographer sometimes refers to the silver in an emulsion, meaning thereby the bromide or chloride of silver. When the statement is made that radium decomposes or gives off emanations or rays, it is wholesome to remember that the bromide of radium generally quite impure, is the substance having these properties. As to the amount and character of the impurities referred to, it would be unwise to hazard a guess. Madame Curie, like her distinguished husband, is far more cautious and conservative in statements about radium than those whose knowledge is derived merely from a few decigrams of the stuff in a sealed tube.

One of the most curious statements about Radium we have lately seen had also an American source. The discovery of radium in the deposits of the mineral waters of Bath is still fresh in mind. The news was apparently cabled over to the States, and in a certain technical journal we read the following:—

> London's ancient city bath has come to the front this week because of the discovery that the old hot

baths contain, in the waters they have been throwing up for centuries, no end of radium which has gone down the throats of invalid drinkers or has been disported in by bathers who must have numbered millions. That excitement has been great over the discovery is shown by the columns which have been published in newspapers and letters discussing the wonderful find.

It all came about in this way: The Hon. R. J. Strutt, son of Lord Rayleigh, while analysing the waters of the bath, found, as he states in a letter which he sent to the Municipal Council of this city, that the waters contain radium in appreciable quantities, etc.

Such is fame! Anyone who has handled "flimsy" will readily understand how this enterprising city of Bath came to be mixed up with London's "ancient city bath," but we cannot help wishing that some of our American friends would come over and know Bath for themselves—more especially since the city has just inaugurated electric trams, and is generally becoming as up-to-date as is consistent with her classic traditions.

It is of course true that there is a London Roman bath near the Strand, and within twenty yards of these offices, but up to the time of going to press we have not heard that any radium has been found in it.

The Institution of Mechanical Engineers.

A very satisfactory report was that presented by Mr. Worthington at the annual general meeting of the Institution of Mechanical Engineers. The total number in all classes on the roll of the institution at the end of 1903 was 4,211, as compared with 3,892 at the end of the previous year, showing a net gain of 319 as against the gains of 238, 243, 325, and 402 respectively during the years which have elapsed since the institution took possession of its new home. Among members removed by death during the year must be mentioned Sir Frederick Bramwell, who joined the institution fifty years ago, and was president in 1874 and 1875; Mr. F. C. Marshall, who was elected member of Council in 1882, and Mr. George B. Lloyd, whose membership dated from 1854. A satisfactory balance sheet was presented, showing a revenue for the year of £10,848.

The report mentions with regard to the Alloys Research Committee that notwithstanding the gratuitous services of those who have organised the experiments, the expenditure upon this research since the formation of the committee in October, 1889, has exceeded £1,800. The first report of the Steam Engine Research Committee by Professor D. S. Capper has been received, and will shortly be presented at a meeting of the institution. It is interesting to note that the Reference Section of the Library (consisting of about 4,000 books and pamphlets) has been rearranged on the Dewey decimal plan.

The spring meeting will be held this year, conjointly with the American Society of Mechanical Engineers, in Chicago, beginning May 31st, and a visit will afterwards be paid to the St. Louis Exhibition.

Proposed Thames Dam.

The scheme to construct a dam across the Thames at Gravesend was recently considered at a well-attended meeting of wharfingers, shippers, and others interested in the Port of London. Sir Thomas Brooke Hitching, who presided, said that the scheme which they had met to consider was proposed many years ago by Mr. J. Casey, a member of the Institution of Naval Architects, and had since been practically worked out by Mr. T. W. Barber, a member of the Institution of Civil Engineers, who called it the Thames Barrage. It was felt that great advantages would accrue to wharfingers and others if the river were barred at Gravesend, as it would enable them to use their wharves all day long, instead of, as at present, only during four hours out of every twenty-four. It would also have the result of making the water as clear in the lower reaches as it was above Richmond and Teddington. The London County Council, in their proposals to establish a steamboat service on the Thames, had always been faced by great tidal difficulties, but with a barrage, giving constant high water, it would be possible to abolish the existing Thames Conservancy piers, which ran out into the river, and to have passenger steamboats as small as those which plied on the Seine and the Elbe. Moreover, the general appearance of the river would be greatly improved by what he had heard described as the canalisation of the Thames.

Mr. J. Casey pointed out that the scheme would allow large vessels to proceed without delay to the upper reaches of the Thames, and so save a large amount of the present cost of cartage.

Mr. T. W. Barber explained that the proposed dam would be of solid masonry, and would rise above the level of the highest possible tides. On the top of the wall would be a roadway, which would connect Kent and Essex, and underneath there would be a tunnel, which could be used by the railways north and south of the Thames. In the centre of the dam a number of locks would be made, capable of taking the largest ships afloat. In addition to the locks, there would be weirs over which the surplus water would flow away into the sea. Gravesend was considered the best part of the river at which to construct the dam. The dredging proposed by the London County Council and in the Government Bill could not be carried out. He maintained that the river could not be dredged to a depth of 15 ft. below its present bottom; even if it could be done, the river walls would fall in. It was important that this barrage scheme should be threshed out before a Parliamentary Committee, as it was a question of spending only £3,000,000 to £4,000,000, as compared with the £40,000,000 with which the ratepayers would be saddled under the Port of London Bill.

THE CIVIL ENGINEER AT WORK.

By C. H.

Railway Developments in China.

Mr. Arthur Judson Brown, in the course of an article contributed to the American Review of Reviews, recalls the fact that the conservatism of the Chinese for many years proved too strong for the promoters of steam railways. In fact the first line, which covered the fourteen miles between Shanghai and Wu Sung was no sooner completed by its British promoters than the Government bought it, tore up the road bed and dumped the engines in the river. This was in 1876. Since then the Chinese have had many object-lessons. If the vast schemes which are at present contemplated by companies of varying nationality can be realised, there will not only be numerous lines running from the coast into the interior, but a great trunk line from Canton through the very heart of the empire to Peking, where other roads can be taken to Manchuria and Korea, or to any part of Europe. The far-reaching effect of this extension of modern railways will, of course, mean a new era for China. The author, after pointing out her agricultural possibilities and immense deposits of coal and iron, remarks that to make these resources available to the rest of the world and in turn to introduce among the 426,000,000 of the Chinese the products and inventions of Europe and America will be to bring about an economic transformation of stupendous proportions.

A curious difficulty but a very formidable one encountered by the railway engineer in China is the omnipresence of sacred graves. This is owing to the peculiar Chinese custom of burying their dead wherever a geomancer indicates a "lucky" place.

Dredging in Montreal Harbour.

Some very interesting details of the dredging fleet of Montreal Harbour were recently presented to the Canadian Society of Civil Engineers by Mr. H. A. Bayfield, A.M.Can.Soc.C.E.

The Harbour Commissioners' dredging fleet proper at present consists of four dipper dredges, five floating derricks, one drill boat, five tugs, and twenty-three scows. There are other machines, but as the work done by them cannot be said to pertain to dredging, no particular mention is made of them. It may be stated, however, that the complete fleet comprises forty-one vessels.

The dredges are all of the dipper or spoon type, their principal dimensions being as follows: Length of hull

MAP SHOWING CHINESE RAILROADS, COMPLETED AND PROJECTED

90 ft., width of hull 36 ft., maximum depth of hold from 9 ft. 6 in. to 10 ft. 9 in., according to dredge; size of main engine 16 in. by 18 in. double cylinder.

The standard bucket employed is of seven cubic yards capacity, and is built with a curved lip and front. There are also a few straight-lipped dippers of five and a quarter yards capacity, but though specially designed for dredging very hard material they have proved not at all superior to the larger bucket, and are, therefore, used only for work in a strong current where swinging is difficult with the dipper of large size, or when filling boxes which the seven yard bucket would overload. The body or shell of both sizes of dippers is of steel plate, with butt joints and single cover strap. The lip and lower band are of cast steel and are riveted to the shell, riveting being countersunk on the inside to insure a smooth surface. The door is composed of a single piece of inch and a quarter steel plate riveted to a cast steel hinge piece. The latching device is on the toggle joint principle, and, considering the extremely severe usage it is subjected to, gives good satisfaction. Bails are a single steel casting, secured to the hoisting wire socket a cast steel shackle. The shackle takes up considerable room, but its use is necesssary to prevent injury to the wire by sharp bending at the point where it enters the socket.

Each dipper carries four teeth which are of cast steel with chisel points. The teeth are made hook-shaped, the hook fitting over the lip at places where projecting lugs are provided to prevent side play. The lower end of each tooth is secured to the shell by four bolts. With this arrangement of fastening, a change of teeth can be effected in about half an hour.

Experiments and Improvements.

Several attempts have been made to design a dipper tooth that will last a reasonable length of time in hard digging. Detachable points of hardened steel were experimented with, but proved a failure through lack of strength either in the point itself, or in the body of the tooth which had to be cut away to receive it.

Silver tips were V welded into the teeth and given a trial in rock digging. It was found that when the points were tempered sufficiently to wear well, they were brittle and broke too frequently to warrant their use.

At present the only effort being made to improve the lasting qualities is confined to heating and dipping the tooth point after it is drawn out under the hammer.

The life of a set of teeth will of course depend upon the nature of the material being dredged. In unblasted grey rock seven hours continuous work is a fair average, as shown by records kept by the writer. Upon becoming too blunt to hold well, the points are again hammered out, but there is a limit to the drawing out process, and the tooth soon goes to the scrap pile.

During last season the four dredges of the fleet used up 181 teeth, each tooth having been in service at least four times.

Considerable trouble has been experienced on account of the very rapid wear of the faces of the latching dogs, even though they have until very recently been made of Manganese steel. Castings of common steel with faces hardened as much as possible are now being tried, and though the duration of the test will not allow of a decision as to the wearing qualities, it is certain that they withstand shocks and blows far better than those of Manganese steel.

Experiments are in progress to determine the advisability of annealing all steel castings used in the construction of buckets and clams. There is no doubt that the initial strain in some of these castings is very high, as its presence is frequently denoted by shrinkage cracks. It is hoped that annealing will relieve more or less of this tension and materially increase the life of the piece.

With regard to riveting, it has been proved that rivets driven by pneumatic tools are superior to those put in by hand. The drift pin seems unavoidable in work of this kind, but it is certain that were all holes drilled fair and good, slack rivets and broken castings would not be so common.

A Model Street.

The new Kingsway from Holborn to the Strand will be a model thoroughfare in many ways, but more particularly by reason of its complete immunity from those periodic upheavals which are characteristic of some of the adjoining streets. On the occasion of a recent visit, the members of the Civil and Mechanical Engineers' Society showed great interest in the shallow tramway works under the new artery, and the difficulties that have been encountered in connection therewith. The subway, starting from a spot close to the New Gaiety Theatre, will pass under the western arm of Aldwych and then north under Kingsway to Holborn. It will then pass under Holborn to Southampton Row, where it will come to the surface at a slope so as to join up with the existing tramway lines that concentrate at Theobald's Road. On each side of the tramway tunnel there will be two subways, which will accommodate gas and water pipes, electric mains, etc. Below each of these side tunnels there will be a sewer. The visitors were first taken into the short length of tunnel at the Strand end, which is nearly completed. Near here, close to the site of the old Olympic Theatre, there will be a station, which will be reached by staircases, but the whole scheme includes a continuation of the tunnel as far as the Embankment. The width of the tunnel will be 20 ft., and the height from the crown of the arch to rail level 14 ft. The pipe subways on each side of the main tunnel will be 12 ft., whilst the egg-shaped sewers beneath will be 2 ft. 8 in. by 4 ft. 6 in. The depth of the tunnel beneath the surface varies from 6 ft. to 14 ft., the greater depth being where the work passes under Holborn and the Strand. At these places the main tunnel will be divided into two smaller tunnels for convenience of construction. Special precautions have been taken to preserve the brickwork from decay by damp, there being a lining of asphalte three-quarters of an inch or more thick. The electric tramcars will be supplied by current from conductors laid in conduits.

ELECTRICAL AFFAIRS.

BY

E. KILBURN SCOTT, M.I.E.E., A.M.Inst.C.E.

Separating Non-magnetic Metals by Electricity.

There appears to be a general impression that it is only possible to separate metals by electrical means when those metals are magnetic. The usual plan is to pass the metal in a finely-divided form in front of a series of electro-magnets. It is probable, however, that any metals, whether they are magnetic or not, may be separated by moving magnets in front of the materials, so that currents are induced in the mineral particles. No one can move copper, for example, merely by approaching it with a magnet, but if a series of magnets of differing polarities pass it in quick succession, then the copper will tend to move by reason of the currents induced in it. In other words, when a rapidly alternating current is generated in a piece of mètal, that metal would rather pass off in the direction of the magnet than have electrical currents flow through it. Sir Hiram Maxim appears to have been an early worker in this field, and it is one in which there would appear to be considerable scope.

A new Alternating Current Flame Arc Lamp.

Messrs. Oliver and Co. have developed an alternating current "flame" arc lamp, which is on an entirely different principle to any hitherto set to work. A few particulars may therefore be of interest.

Two flame carbons, each 8 millimeters in diameter and 18 in. long, are placed side by side in metal tubes, the space between being about ⅜ in. Alongside the carbons there is a glass rod about one-sixteenth of an inch in diameter, and the same length, in a separate metal tube. The arc is struck by means of a piece of carbon mounted on a short bell-crank lever, which rests against the ends of the two flame carbons. Immediately current is switched on, a solenoid pulls the short circuiting piece away, so striking the arc.

The end of the glass rod projects very slightly from the metal tube, and its upper end carries a weight which also rests on the top of the two flame carbons. By an ingenious magnetic deflecting device the arc plays on the lower end of the glass rod and in due time melts off a small piece, thus allowing the rod to drop about one-sixteenth of an inch. The flame carbons are then pushed down the same amount. It should be mentioned that the carbons are held up by weighted friction clutches. The two carbons and the glass rod are thus burnt away at the same time. The feature of the lamp is that there are no solenoids other than the one for working the bell-crank lever, the arc is also horizontal, and therefore gives no shadow from the lower carbon. One of these arc lamps on the Leeds Market circuit takes 34 volts 10 amperes, and absorbs 400 watts on the primary side of the step-down transformer.

Winding Field and Transformer Coils.

In winding copper wire on to a field coil, it is usual to place a brake on the spindle of the spool which is being unwound so as to keep the wire taut. This naturally gives a side pull on the bearings of the lathe, and there is considerable friction. It occurs to the writer that if two spools were wound on the same lathe and the wires guided on to the spools from opposite directions, say top and bottom, these side pulls would be neutralised to a large extent.

The present tap tapping of the wire with wooden mallets is anything but satisfactory, and what appears to be wanted is a change gear, which would move a small pair of gripping wheels, the exact distance represented by the diameter of the wire, at each revolution. A knock-off reversing motion would, of course, be necessary to start the wire back again when it reached the end of each layer.

It almost goes without saying that there should be a revolution counter on every winding lathe, otherwise it is difficult to ensure that the exact number of turns will be wound on. With the shunt coils of a multipolar dynamo it is most important that each pole should give the same number of ampere turns, otherwise there will be unbalancing. As the coils are connected in series, the number of turns must be the same on each coil.

In the case of similar sized transformers which have to bank together, it is also important to have the turns exectly the same on both primary and secondary coils.

Steel Conduit Tubing.

The use of steel conduit tubing for carrying electric cables is very rapidly taking the place of wooden casing. Among the debatable points in connection with the use of such tubing is the question whether the interior should be lined. Soapstone powder is used to assist the drawing in, but by lining with some smooth material the cables can be drawn in without any risk of abraiding to the insulation. At the same time, such material may act as an insulator. In one particular make of conduit the interior is lined with one-sixteenth of papier mache, impregnated with bitumen.

Another point in connection with steel tubing is the question of sweating on the interior surfaces, this being due to the fact that the temperature inside is raised by the current flowing through the cable. There is much less risk of such sweating occurring if the tube is lined, but in any case it is probable that it would be of considerable benefit to withdraw the moist air from the interior of the conduit after it has been installed, in much the same way as is done with telephone wires.

The few accidents which have occurred with steel tubing have been due to the fact that the tubing was not properly earthed. This is a most important matter, and it is not only necessary to see that the tubing is well earthed, but also to be sure that there is good conductivity between the joints. Such joints should be metal and any white lead or paint which is employed for making the conduit airtight should be beyond the screwed portion.

POWER STATION NOTES.

BY E. K. S.

The Drainage of Steam Pipes.

In most steam-pipe systems working with ordinary saturated steam, it will be found that there is a stream of vapourymoisture flowing along the bottom of the piping. (Tests for wetness of steam should therefore be made at the bottom of the pipe, and not at the centre.) It happens that this moisture is not only a danger when it manages to get into the engine cylinders, but it has also the effect of washing out the cylinder oil.

In this country the usual plan is to provide numerous steam-traps to catch this water, but in the States, a steam-loop system such as the Holly is generally employed. This system has been fitted to the Bath Tramways' power-house by the Westinghouse Co., so a short description may be of interest. In its simplest form, the Holly system consists of a receiver placed below the lowest point to be drained, a riser pipe, and a drop leg, the whole forming a loop to the main steam range.

The riser pipe and drop leg are carried high enough to enable any water which accumulates in the drop leg to force its way into the boiler by gravity. The reason for the water and moisture finding its way up the riser pipe is because means are provided (by condensation) for causing a lowering of pressure at the top of the pipe. Naturally the steam tends to flow towards this reduced pressure point, and in so doing it carries with it any primage or condensation water and vapoury moisture. Suppose the pressure in a given boiler is 100 lb., the pressure at the engine 95 lb., and in the drop leg 94 lb. There will then be 6 lb. difference between the boiler and the drop leg, and a column of water in this drop leg standing 14 ft. above the level of the water in the boiler will provide sufficient hydrostatic head to balance the difference in pressure.

By maintaining the necessary difference in pressure at the high point of the system, the drop leg column reaches a height corresponding to this constant difference and rises no further. It is then in full action, and maintains circulation so long as steam is in the system.

The method has the advantage of being absolutely automatic and comprehensive in action, and it operates whether much or little water is present and at all times, day and night, without any attention whatever. As the water returned to the boilers is absolutely pure, it is possible to reduce scale by concentrating the water into one or two boilers at a time. In one case, the system provided the entire feed in one boiler in a battery of twelve.

The Tangential Water-Wheel.

The simplest of all the prime movers which are in use to-day is undoubtedly the Pelton wheel, or, as it should more properly be called, the tangential water-wheel. It is closely associated with the development of electric transmission in the Western States of America, where it has been developed from the old Hurdy Gurdy wheel of the gold miners. In the modern wheel the water strikes double-curved buckets, and the impulse causes rotation. Further, the buckets are so shaped that the direction of the jet is reversed almost back upon itself, and this reversed flow, as it emerges, is reactive, and tends to further increase the power and speed of rotation.

As compared with the turbine, the first cost of the tangential wheel is very much less, and for high heads *i.e.*, several hundreds of feet, it can be used where a turbine is quite impossible. At the same time its cost of maintenance is but a fraction of that of the turbine, for a complete set of new buckets costs very little, and can be mounted in an hour or so by an unskilled man. Regarding efficiency, any good make of wheel will give over 80 per cent., and there is this to be said, that it maintains its efficiency, whereas a turbine constantly decreases as the wheel wears away in the casing, thus allowing the water to pass by instead of through.

A disadvantage of the turbine is that the variation in design is limited by reason of its excessive cost for large diameters. The tangential wheel, on the other hand, permits of very wide and free scope. Single wheels have been built to give 3,000 h.p. on a 1,500 ft. fall and a speed of 240 revolutions per minute. The highest heads for which tangential wheels have been built are 2,530 ft. at Seattle, 2,250 ft. at Panuco Mine, Mexico, and 2,100 ft. at Pike's Peak, U.S.A. These give pressures of upwards of 1,000 lb. per square inch at the nozzle, so it will be seen that the engineering of these high falls is no child's play.

Advantages of High over Low-Head Falls.

A glacial stream or mountain torrent is much better for the purpose of power work than water at a lower altitude, because when the water is led into pipes at a point above the tree-line there is so much less risk of organic matter getting past the strainer. In the case of a river on the other hand, expensive gratings and strainers are necessary to catch wood, leaves, and other smaller floating obstructions. In some power installations a gang of men is kept constantly at work clearing the strainers.

A low fall is generally in a valley, where land is valuable and where, if the water rights are interfered with there may be legal difficulties. A mountain stream, on the other hand, generally runs through land of little value. It should also be remembered that with the small amount of water required from a high head it is much easier to provide for storage to carry over periods of drought. A few feet difference in the height of such a reservoir makes little or no difference to the power, whereas on a 50 ft. fall two or three feet in height of the storage reservoir or the tail race makes a considerable difference in the power available.

High-Head Water Powers.

Travellers, as a rule, are only impressed by falls of moderate height over which the water comes tumbling in masses. They do not appreciate the fact that a mountain stream dropping 1,000 or so in a short horizontal distance may be capable of developing much more power at a fraction of the expense. The result of this is that, with the exception of California and the Western States of America, very little has been done to develop high-head water powers.

In the Colonies, South America, and Africa, as well as India and the Far East, there are numerous high-head falls waiting to be put into use for the purpose of electric transmission. The rapid development which has taken place in the Western States, and the enormous distances to which the current is transmitted (80, 99, 142, and 180 miles are four of the longest transmissions) show that the generation of electricity from high-head falls is a paying business.

IRON AND STEEL NOTES.

By E. H. B.

Mr. R. A. Hadfield and His Work.

Mr. R. A. Hadfield has been contributing to the "Iron and Steel Metallurgist and Metallographist," published at Boston, Mass., some valuable notes on iron and steel alloys. He remarks that the examination of the properties of iron alloyed with other elements is being continued with increasing vigour, and valuable results, both from the immediate practical as well as the scientific point of view, are accruing to the world from the labours of the metallurgist. Nowadays we do not hunt for the philosopher's stone, but verily the metallurgist has produced "transmutations" that even ten years ago would not have been thought possible. The writer has produced alloys with tensile strengths all the way from 18 tons up to 110 tons per square inch, and with elongations from nil to 70 per cent. But, singular as it may seem, notwithstanding the important part played by all these new iron alloys, carbon still maintains its premier position in determining the practical value of the various products, in other words, there are few, if any, iron alloys in which, apart from the effect produced by the special element added, the presence of carbon is also unnecessary; therefore, whatever the theory believed in by each reader of this article, that is, whether he is a carbonist or allotropist, it has to be admitted that carbon alone is the predominant factor in determining the utility of the alloy. The writer is not stating this in any controversial spirit, as, of course, the allotropist, whilst admitting the importance of carbon, claims its action is different to that believed in by the carbonist, but the fact remains that carbon must be present to render the alloy of practical value.

Finally, says Mr. Hadfield, may it not be claimed that the world is more than ever indebted to that indefatigable body of men, the metallurgists, who labour on, year by year, through difficulties often apparently insurmountable, to improve and perfect the qualities of iron for the general benefit of mankind.

As the article is for the first number of the enlarged "Metallographist" of America, Mr. Hadfield takes the opportunity of wishing God speed to the members of his craft in their work in that great Republic, where he has always received so much personal kindness and courtesy. He offers every good wish for continued success to the editors in the continuation of their efforts to improve and enlarge the stores of information on metallurgical matters.

Transvaal Ironworks.

The *African World* states that the site of the proposed new ironworks in the Transvaal will not be at Onderstepoorte, north of Pretoria, as was originally intended. Although the great project will be carried out in its entirety, certain bank assays on the Onderstepoorte ore, made at Johannesburg last May, have been found to be quite untrustworthy.

The Iron and Steel Institute.

The annual general meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers on Thursday and Friday, May 5th and 6th. The annual dinner will be held—under the presidency of Mr. Andrew Carnegie—in the Grand Hall of the Hotel Cecil, on Friday, May 6th.

Meeting in the United States.

The autumn meeting will take place in New York on October 24th, 25th, and 26th. After the meeting there will be an excursion to Philadelphia, Washington, Pittsburg, Cleveland, Niagara Falls, and Buffalo, returning to New York on November 10th. During the trip night travelling will be avoided, and every endeavour will be made to obviate fatigue. The two Sundays will be spent at Washington and at Niagara Falls. The approximate cost of the stay in the United States is estimated at £25. For the convenience of members desirous of visiting the St. Louis Exhibition, arrangements will be made for a limited number to leave Pittsburg for St. Louis and Chicago, reaching New York on the evening of November 10th. This trip will necessitate three nights being spent in sleeping cars, and the approximate cost will be £35.

An influential committee has been formed in the United States for the reception of the Institute, Mr. Charles Kirchhoff being the president and Mr. Theodore Dwight (99, John-street, New York), the hon. secretary.

The Heat Treatment of Steel.

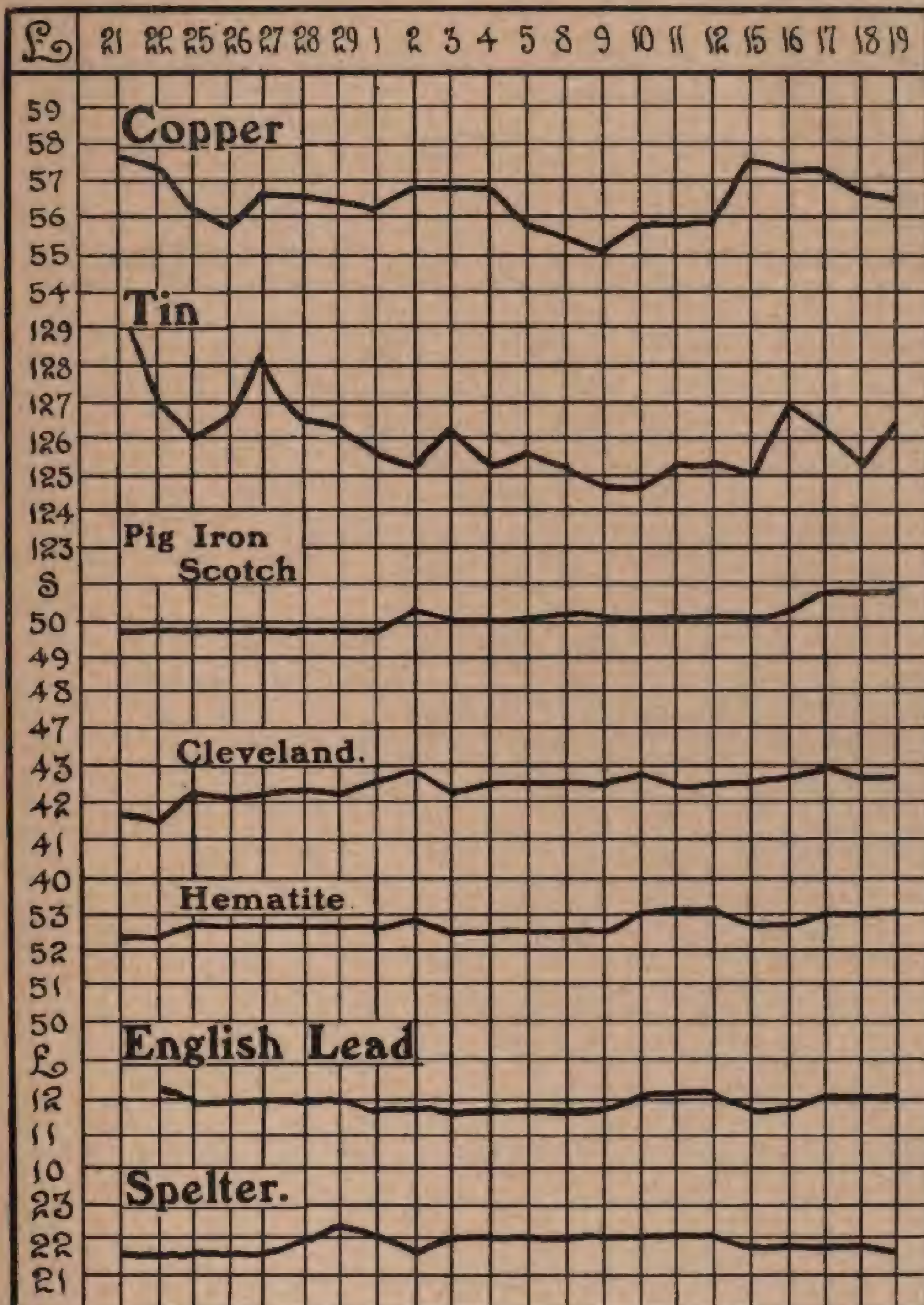
A very interesting work on the "Hardening, Tempering, Annealing, and Forging of Steel," by Joseph V. Woodworth, is to hand from Messrs. Archibald Constable and Co., Ltd. It deals with the practical side of a subject that is now very prominent, and presents a great deal of useful information, in compressed and easily accessible form. To indicate the style of the work I cannot do better than quote one or two paragraphs.

Points to be Remembered.

To heat and cool steel properly, says Mr. Woodworth, remember the following: Never heat a piece of steel which is to be annealed above a bright red. Never heat a piece to be hardened above the lowest heat at which it will harden, and the larger the piece the more time required to heat it is required, which will have to be higher than a smaller piece of th same steel, because of the fact that a large piece takes longer to cool than a smaller piece, as when a large piece of steel is plunged into the bath a large vo ume of steam arises and blows the water away from it, thus necessitating more time in the cooling. Thus when the tool or die is very large, a tank should be used to harden it in, into which a stream of cold water is kept constantly running, as otherwise the red hot steel will heat the water to such a degree that the steel will remain soft.

Different Quenching Baths—Their Effect on Steel.

On this question the author remarks that, next to proper heating, more depends upon the quenching



THE HOME METAL MARKET.

Chart showing daily fluctuations between January 21st and February 19th, 1904.

than anything else. It follows that the effects of the use of the various kinds of baths are required to be understood. The most generally used bath is usually cold water, though not infrequently salt is added or a strong brine is used. The following will be found to answer well for the work mentioned: For very thin and delicate parts, an oil bath should be used for quenching. For small parts which are required to be very hard, a solution composed of about a pound of citric acid crystals dissolved in a gallon of water will do. For hardening springs, sperm oil; and for cutting tools, raw linseed oil will prove excellent.

Boiled water has often proved the only bath to give good results in a large variety of work, the parts requiring hardening being heated in a closed box or tube to a low red heat and then quenched. Sometimes the water should be boiling, at others quite hot, and then again lukewarm. Experience will teach the operator which is the best for special work. If a cutting tool, such as a hollow mill, a spring threading die, or a similar tool, is to be hardened in a bath of this sort, dip it with the hole up or the steam will prevent the liquid from entering the hole and leave the walls soft. A tendency to crack will also prevail if this is not done. The generation of steam must be considered when hardening work with holes or depressions in it, and attention must be paid to the dipping of the part so as to prevent the steam from crowding the water away. Clean water steams rapidly, while brine and the different acid solutions do not.

Hardening Large Milling Cutters.

It is remarked that large, plain or former milling cutters, say over 3½ in. in diameter and 4 in. long, to harden should be packed in a mixture of equal quantities of granulated charred leather and charcoal, taking care not to have any part of the mill within, say, 2 in. of the box at any point. Keep it in the furnace for four to four and a-half hours after the box is heated through to a low red; remove the box from the furnace at the expiration of the time and quench the cutter in a bath of raw linseed oil, twirling it around rapidly in the oil so as to cause the oil to come in contact with the teeth. Allow the cutter to remain in the oil until cold. A formed mill with heavy teeth does not need to have the temper drawn. Mills with teeth cut in the ordinary manner should be run quite as long, and may be drawn for ordinary work to a light straw colour, or if drawn in a kettle gaging the heat by a thermometer to 425 or 430 deg. F. We have seen a large number of milling cutters and similar tools treated by this method and have never known one to be lost by cracking. In years of experience with this method we have had but a few pieces crack.

Mr. Woodworth's work is thoroughly practical, and its value is greatly enhanced by numerous illustrations and an excellent scheme of arrangement.

COMING EVENTS—MARCH.

3rd.—Civil and Mechanical Engineers' Society: General Meeting, Caxton Hall at 8 p.m.—Birmingham Engineering Society: Visit Bumsted and Chandler's Works, Hednesford.

5th.—Birmingham Association of Mechanical Engineers: Monthly Meeting.

7th.—Society of Engineers: Meeting at the Royal United Service Institution.—Edinburgh University Chemical Society: General Meeting.—Institution of Marine Engineers: Meeting at Stratford, E., at 8 p.m.—Society of Arts: Cantor Lecture.—Birmingham Association of Mechanical Engineers: Visit Messrs. Thompson's Boiler Works, Ettingshall.

8th.—Junior Engineering Society: Meeting at the G.W.R. Mechanics' Institute, Swindon.

10th.—Institution of Electrical Engineers: General Meeting.—Association of Birmingham Students of Civil Engineers meet.—Birmingham University Engineering Society meet.

12th.—The Manchester Association of Engineers: General Meeting.

14th.—Society of Arts: Cantor Lecture.—Edinburgh University Chemical Society: General Business Meeting.—Institution of Mechanical Engineers: Graduates Meeting at 7-30 p.m.

15th.—Junior Engineering Society: Meeting at the G.W.R. Institution, Swindon.

16th.—Institution of Civil Engineers: Annual Dinner at Lincoln's Inn Hall—Sir W. H. White presides.—Birmingham Local Section Institution of Electrical Engineers: Visit British Thomson-Houston Company, Rugby, followed by Meeting in the University.

17th.—Institution of Mining and Metallurgy: Meeting at 8 p.m.—Birmingham University Engineering Society, General Meeting.

18th.—Institution of Mechanical Engineers: Meeting at 8 p.m.—City of London College Science Society: General Meeting.

19th.—North-East Coast Institution of Engineers and Shipbuilders: Meeting of Graduate Section at Sunderland.—Staffordshire Iron and Steel Institution: General Meeting.

21st.—Society of Arts: Cantor Lecture.

23rd.—Institution of Naval Architects: Annual Dinner at 7.15 p.m.

24th.—Institution of Electrical Engineers: General Meeting.—Birmingham Local Students' Institution of Civil Engineers: General Meeting.—Institution of Naval Architects: Annual Meeting.

25th.—North-East Coast Institution of Engineers and Shipbuilders: General Meeting.—Institution of Naval Architects: Annual Meeting.

26th.—The Manchester Association of Engineers: General Meeting.

29th.—Junior Engineering Society: Annual General Meeting at the G.W.R. Institution, Swindon.

31st.—Leeds Association of Engineers: General Meeting.

AUTOMOBILE DEVELOPMENTS.

By J. W.

It is announced that an automobile society has been formed in Calcutta, which will be known as the Automobile Association of Bengal.

It is interesting to note that the Berlin postal authorities are making use of motor vehicles for the conveyance of mails between the general post office and the suburbs of Schöneberg.

The side slip trials arranged by the Automobile Club are to be held about March 25th, and it is announced that a private track has been kindly lent for the purpose. The competition must necessarily involve a great deal of trouble to the organisers, and it will be interesting to see how the track is treated for this unique competition.

On March 19th to the 26th, Cordingley's Ninth International Automobile Exhibition will be held at the Royal Agricultural Hall, London. There will be ample opportunity to compare British machines with foreign productions, and an interesting feature will be a collection of war balloons and air-ships, which will be exhibited by the Aero Club.

Motor Vehicles for Agriculture.

The practical application of motor vehicles to agriculture is well illustrated in a motor manufactured by the Ivel Agricultural Motors, Ltd. This is expressly designed for operating ploughs, mowing, reaping, chaff-cutting, churning, etc. It can also be used as a tractor or for stationary work, such as chaff-cutting, pulping roots, and grinding corn. The motive agent is petrol, and the machine, which is simple in construction, develops about 8 h.p.

O'Gorman's Motor Pocket Book* is a work which is to be cordially recommended not only to those who habitually use the automobile in one form or another, but also to engineers who desire to keep themselves well informed as to the progress made in the technicalities of the subject. Those who are newly taking up motoring will find it a veritable vade-mecum, for it is arranged on the dictionary plan, and it would be hard to name a subject useful to the motorist, from accumulators to wire gauges, that is not succinctly dealt with.

The New York Show.

There was a large display of electric vehicles at the recent automobile show at Madison Square Garden, New York. Out of a total of 250, nearly 50 were of the electric class; 175 were gasoline, and a dozen were steam motors, the others being also gasoline but of the motor bicycle type. An electrical contemporary remarks that there is nothing in such figures to make electrical engineers despair of the future, especially as a large proportion of the electrics were not of the fancy type but were strictly industrial and utilitarian.

The show, which was held under the auspices of the Automobile Club of America, was not remarkable for any particular novelty, but it showed a marked advance over its predecessors. A great many of the electric automobiles were of the commercial type.

The International Motor Boat Contest.

We are informed by Mr. Basil H. Joy, technical secretary to the Automobile Club, that three challenges were received from France for the British international cup for motor boats before the last day on which a challenge could be received. Two of these entries are for boats driven by petrol motors, one from MM. Clement and the other from Messrs. G. Pitre and Co., and the third is a Gardner-Serpollet steam launch, entered by MM. Legur and Gardner. No less than seven boats have been entered to defend the cup on behalf of Great Britain, two being from Mr. S. F. Edge, the present holder, three from Messrs. J. E. Hutton, Ltd., one from Messrs. Thornycrofts, and one from Lord Howard de Walden. This will necessitate an eliminating race being held to decide upon the three boats which are to represent England in the race itself. Further entries, it is hoped, will yet be received from France, which will also necessitate an eliminating test, and if, as is confidently expected, entries are received from Germany and the United States, the race will be the most representative and important international contest for motor boats that has ever taken place. The actual date of the race, which will be held probably in the Solent, is to be July 30th.

The Crystal Palace Show.

The remarkable progress of the English automobile industry was well illustrated at the Crystal Palace Show, where a space of 130,000 square feet was eagerly taken up by motor manufacturers and traders; in fact, it is impossible to avoid feeling that our home manufacturers have scored a triumph. The excellent show of motor agricultural machinery must have been particularly instructive to visitors from the country, and should lead to further important developments in this direction, while another very interesting feature was to be found in the steel motor boats. The *Times* calls attention to the fact that the British manufacture has practically doubled itself during a year by no means remarkable for commercial activity, and that a number of the great engineering firms of Great Britain have taken in serious earnest to the production of motor cars. Amongst them, without attempting an exhaustive list, may be mentioned Sir William Armstrong, Whitworth and Co., the Hozier Engineering Company, Messrs. Croxley, Messrs. Ransome—the last-named bring the motor to the aid of the gardener—and Messrs. Thornycroft. Side by side with these, the firms which live for the production of motors only—it would be invidious to name a few in this connection, and it is impossible to name them all—have redoubled their efforts; and the satisfactory result is that the proportion of British to foreign exhibits is far larger than heretofore. For ingenuity, variety, and engineering finish, the British exhibits certainly need not fear comparison with any that are foreign. In fact, there is no reason why a purchaser who would rather see his money go to his fellow-subjects than to foreigners should seek the aid of Continental or American manufacturers except that, rapidly as the British trade has increased, it has by no means kept pace with the British appetite for motor vehicles. All this is very encouraging for the motor industry, and we venture to hope that the "appetite" will, nevertheless, be largely met at home. The exhibition included 270 stands and over 1,000 cars were shown, in addition to heavy vehicles and boats, and innumerable accessories.

* Published by Archibald Constable and Co., Ltd. Leather, 7s. 6d. net.

AMERICAN RÉSUMÉ.

BY OUR NEW YORK CORRESPONDENT.

NEW YORK, February 19th, 1904.

A Large Guillotine Shear.

The largest guillotine shear ever built by the Hilles and Jones Company was recently installed in the warehouse of Joseph T. Ryerson and Son, Chicago. The upper blade is 13 ft. 2 in. long and will shear a plate 1½ in. thick and 12 ft. long, working between the housings. The overhang or gap is 36 in., which feature permits a strip 36 in. wide or less to be sheared from the side of a plate of any length, the plate, of course, being moved along parallel with the blade after each stroke. The shear complete weighs 220,000 pounds. It is driven by a 50 h.p. Westinghouse three-phase motor, direct connected by gearing and a friction clutch. The frame stands 21 ft. above the floor and the total width is 22 ft.

The Chicago Fire and After.

The terrible fire at Chicago may not after all be without its advantages. Architects and builders, who make it a business to remodel buildings, are extremely busy in Chicago and the West now, as a result of the rigid enforcement of rules and ordinances for fire protection. Not only theatres and halls are undergoing reconstruction, but many churches and other places of assembly will have to be completely remodelled. Every manufacturer of fire escapes and steel and iron stairways is crowded with rush work. Thousands of workmen are finding employment, and it is believed that in Chicago alone $1,000,000 will be expended for rendering buildings safe that have not been sufficiently so.

American Pig Iron.

James M. Swank, general manager of the American Iron and Steel Association, has published his statistics of the production of pig iron in the United States for 1903, the report being based on complete returns from every furnace in the country.

The total production of pig iron in 1903 was 18,009,252 gross tons, against 17,821,307 tons in 1902, 15,878,354 tons in 1901, 13,789,242 tons in 1900, 13,620,703 tons in 1899, and 11,773,934 tons in 1898.

1904 Electrical Congress.

Over eight hundred have already accepted membership of the 1904 International Congress, which European engineers are now being invited to join. As some of the best electricians in Europe and America have promised to contribute papers to the sections in September, it is anticipated that the transactions will have an exceptional electro-technical value.

Producer Gas from Wood.

A most novel feature of the power plant of the Montezuma Copper Company at Nacozari, Sonora, Mexico, as described by Mr. John Langton to the American Institute of Mining Engineers, is the use of producer gas made from wood alone. No guiding experience was found for this process; but, with the desire to utilise as far as possible the limited local wood-supply, the gas-producer plant was selected with the object, among other things, of determining the advisability of using, if not wood alone, at least a considerable admixture of wood with bituminous coal. The power-plant was started in operation July 31st, 1900, with coal; but for some months there was no convenient opportunity to experiment with wood, and it was not until February 4th, 1901, that the first trial of wood alone was made.

The most obvious difficulty to be feared arose from the large proportion of condensible distillates yielded by wood, and the danger that some portion of these might be imperfectly fixed in passing through the producer. The trouble from tar deposited in the gas apparatus and pipes would be serious, and even a small quantity of tar in the gas itself is a fertile source of trouble at the engine valves. Unless a permanent gas could be made from wood, this fuel would be unavailable.

The first care, therefore, was to insure that there should be a bed of charcoal on the grate sufficient to form an adequate fixing zone. To obtain this the producers were filled about 5 ft. deep with cordwood sawn in blocks about 6 in. long, and the contents blown with a slow fire for four or five hours before the gas was turned into the holder. The gas, as it proved, was turned into the holder too soon. At first, it contained some tar and it was not until after about three hours' operation that the charcoal accumulated in sufficient quantity, so that the producers delivered fixed permanent gases to the holder. This was evident on exposing white paper to the gas.

This preliminary trial lasted more than twelve hours, until the supply of sawn wood was exhausted. As was expected, upon drawing the fires a considerable quantity of charcoal was obtained, which was available for use as a bed in starting the succeeding fires. But before the next trial was made it was decided that for this purpose coke would be better than charcoal, and the practice has been continued ever since. The experience at Nacozari, however, does not determine whether it would be safe to dispense with the use of coke.

The second trial, beginning March 14th, was carried on for 66 hours with perfect success; and after a third trial of 36 hours' duration, made a few days later, had proved that there was no difficulty in repeating the previous excellent results, measures were taken to gather a supply of wood sufficient to operate the plant with wood-gas exclusively.

The wood used is principally scrub white oak, with about 10 per cent. ash.

The American Civil Engineers.

At the annual business meeting of the American Society of Civil Engineers at New York, the most

important matter taken up for discussion was in regard to accepting the proposition of a joint building for the various national engineering societies as a gift from Mr. Andrew Carnegie. It was decided to instruct the Board of Direction to issue a letter ballot to the membership, to be canvassed at the meeting of the society on March 2nd.

It was shown that 212 members had been added to the roll during the year, bringing the total to 2,924, of whom 718 are resident members and 2,206 non-resident.

Mining Yellow Ochre.

A paper recently presented by Mr. Thomas Leonard Watson to the American Institute of Mining Engineers, dealt with the "Yellow Ochre-Deposits of the Cartersville district, Bartow County, Georgia."

The principal use made of the Cartersville ochre at present is in the manufacture of linoleum and oil-cloths. For this consumption the principal markets are in England and Scotland, to which the bulk of the Cartersville product is exported. Some of it is used in the United States for a similar purpose. It is also used to a limited extent in the manufacture of paints. By calcining, the ochre is converted into a desirable dark-red pigment.

The ochre-deposits to be mined in the Cartersville district form extremely irregular branching veins, which intersect the rock in almost every direction. The ore-bodies may occur enclosed in the hard and fresh quartzite, or they may be entirely enclosed in the residual decay derived from the quartzite. The bodies of pure ochre are usually soft and clay-like in character, and the ore is easily mined with the pick and shovel. They are generally exposed along the slopes and summits of the quartzite hills and ridges.

On those properties in the district where systematic mining has been done, the method employed consists of tunnels driven into the ridge, from which drifts are worked at suitable points. In this way a number of levels have been worked, one above the other, on several of the properties. Occurrence of the ochre in the fresh rock, as on the Georgia Peruvian Ochre Company's property at the wooden-bridge across the Etowah river, at times necessitates blasting.

Timbering is necessary in the tunnelling, as caving is apt to occur. The underground-mining is also extensive enough to necessitate tramways and lights. The tram-cars are drawn in and out of the mines either by mules or by means of steam and cable. Both are in use in the Cartersville mines.

Steel Cars for New York Subway.

According to the *Iron Trade Review*, the American Car and Foundry Co. has contracted with the Interborough Co., of New York, which will operate the underground rapid transit and leases the Manhattan Elevated, to furnish the underground railway with what are said to be the first steel non-combustible passenger cars ever built or designed. The contract involves about 1,500,000 dol., and calls for 200 cars. The design of the new car was worked out by George Gibbs, consulting engineer of the Interborough Co. These cars will be built at the Berwick plant of the American Car and Foundry Co. The cars are to be delivered next summer. It is pointed out that owing to the frightful accident in the Paris tunnel last summer the Interborough Co. has desired to spare no expense in order to avoid accidents to passengers. When the subway starts in active operations there will be 500 cars put on. If the all-steel cars prove successful they will gradually replace the others.

A Large Smelter Chimney.

From the standpoint of volume of gas discharged the new chimney at the Washoe Smelter, at Anacond, Mont., will be the largest in the world. Others are taller, but their diameter, and consequently their capacities, are smaller. When completed the base of this stack will be 45 ft. square, while the top will be 36 ft. in outside diameter, 300 ft. from the ground, and 6,182 ft. above the sea level. A flume 2,667 ft. long will convey the gases from the roaster to the base of the stack, and be the cause of precipitating much of the poisonous matter usually thrown into the air. Arsenic is one of these impurities and it exists in such large proportions in the smoke that plans for a possible refining of this as a by-product are under consideration. The chimney will be constructed of red brick and concrete, and is expected by its great elevation to carry the noxious fumes from the smelter to the upper air currents, where they may be thoroughly and harmlessly dissipated.

Electric Cars in Korea.

On January 24 the United States State Department at Washington received official information of an attack by a mob of native Koreans on an electric car because it had killed a Korean. The news came in the following cablegram received from Minister Allen at Seoul: "This morning on the electric railway, which is the property of American citizens, a Korean was accidentally and unavoidably killed. Thereupon a mob of natives attacked and partially destroyed the car. The operators of the car would have been injured had it not been for the presence of mind and action of our guard, and a serious riot would have occurred." Although there have been previous reports of disturbances in Korea, says the *Electrical World*, this is the first mob attack made on the property of Americans. The railroad is owned and operated by Americans, H. R. Bostwick, of San Francisco, and H. Collbran being its principal officers. It runs through the heart of Seoul. The United States Legation guard now consists of 100 marines. The reinforcement of this guard has been urged, and could be effected in a week's time by details of marines from the Philippines.

SOUTH AFRICAN RÉSUMÉ.

BY OUR JOHANNESBURG CORRESPONDENT.

JOHANNESBURG, February 12th, 1904.

Navvies in the Transvaal.

A large experiment in the employment of white unskilled labour has been terminated in an unsatisfactory manner during the last month by the dismissal of 963 navvies who had been employed for the preceding ten months on the construction of 20 miles of earthworks on the Springs-Ermelo line of railways.

The men, after a fairly good start, reduced their output until Mr. Wall, the Chief Constructor, visited the works, and, by dint of persuasion and the institution of a system of bonuses, induced them to renewed efforts which resulted in an average of 6½ cubic yards per man per day for a time. But afterwards the amount of work gradually fell off again until it actually fell to a little over 1 yard per man. This being reported to the authorities, the latter decided to stop the work and send the men back to England.

This decision cannot be wondered at, for, according to the writer's own experience of railway construction in this country, the average work done by Kaffirs in ordinary pick and shovel ground, on monthly wages, without any special inducements, ranges from 3½ to 4 yards per day per native. Mr. Wall states that the extra expenditure on the 20 miles due to the substitution of white labour for black amounts to £75,000. This probably includes the cost of importation and other items which would not recur frequently if the men had worked well and remained in the country, but the other figures given show that white labour does not, and cannot, compete against black in South Africa as regards cost, unless the former receives what is a starvation wage, a state of things which nobody desires to see established.

It has been stated that "the navvies did not desire to acquire efficiency or to make their work valuable," and, again, that "they would not work," but such bald, unsympathetic statements do not take sufficient account of the climatic conditions, and the effect on a white man of severe and continuous manual labour out in the open for prolonged periods. So that, although this failure tends to further prove that white unskilled labour cannot be profitably employed on a large scale, it does not necessarily show that the fault lay with the particular men in question.

The Passing of the Rand Central Ore Reduction Company.

Had this company been merely a dividend-earning concern its decision to go into voluntary liquidation would call for no comment in these columns. But it has been so closely associated with the expansion of metallurgical practice on the Rand that its career has been of considerable technical interest.

Formed in 1892 for the purchase and treatment of concentrates and large heaps of tailings, it had in June, 1894, six separate cyanide plants at work on sand treatment and one chlorination plant for concentrates.

As, however, the advantages and methods of cyanide treatment became more widely appreciated, the mining companies preferred to build their own plants instead of selling their tailings. The Rand Central, therefore, diverted its energies necessarily into new channels, and besides constructing many of the new plants for the mines, also experimented upon the treatment of slimes. About the same time it introduced the Siemen's electrolytic method of precipitation, and established a refinery for the treatment of the lead bullion produced by this process.

In 1897 a blast furnace was put in operation for the production of pig lead and silver from the galena ores mined near Pretoria. This was followed by the erection of mills and presses for the manufacture of lead foil, sheet lead and pipes.

The principal factors which have led to the proposed liquidation have been officially given as follows: The unfavourable results in many instances obtained from slimes purchased by contract, the unexpected difficulties encountered in the treatment of old accumulated slimes. The enforced idleness of the plants during the war. The decrease in quantity and value of the by-products purchased from the mines which has resulted from improved methods and more careful work on the part of the mining companies. The abolition of the duty of £25 per ton on imported lead, coupled with the present scarcity of lead ore and the high cost of its transport.

Precautions against Gassing.

A member of the Chemical Metallurgical and Mining Society of South Africa sets forth in the journal of that society the recommendation that every mine be provided with a cylinder of oxygen and fan piece for use in cases of "gassing."

The elimination of the CO from the blood and tissues begins to take place directly the person is removed from the poisonous gas into the ordinary air. As decomposition of the carboxyhaemoglobin is the result of a mass action depending upon the relative quantities of oxygen and carbon monoxide brought into intimate contact with the haemoglobin, and as the affinity of carbon monoxide for haemoglobin is very much greater than that of oxygen for haemoglobin, the greater the amount of oxygen which can be brought into contact with the blood in a given time the more rapidly will the carbon monoxide be turned out of the blood.

When a person who has been even partially gassed has to recover by breathing ordinary air, each breath he takes contains four-fifths of the diluent nitrogen, so that only one-fifth of the volume of air he inhales enters into the reaction. It is obvious, therefore, why absolute recovery is so prolonged. If, however, pure oxygen be inhaled in lieu of air, the volume of oxygen actually reaching the lungs at each inspiration being so much greater than when ordinary air is breathed, the carbon monoxide will be driven out of the haemoglobin at a much greater rate.

GERMAN RÉSUMÉ.

BY

DR. ALFRED GRADENWITZ.

BERLIN, February 22nd, 1904.

A Novel Electric Traction System.

An electric railway traction system of quite a novel kind is being developed at the present moment by a Swiss "Studiengesellschaft," appointed for the purpose of finding out an electric railway system suitable for that country, which on account of her dependency on the foreign coal market should endeavour to utilise her wealth of hydraulic power. Speeds, on the other hand, are limited there because of the steep gradients, sharp curves, and numerous stoppages. In the system in question, as described in a recent issue of the "Elektrotechnischer Anzeiger," steam locomotives heated by electricity are adopted. Electric heating, as is well known, will work with the highest possible efficiency, so that the total efficiency mainly depends on the output of the mechanical part of the locomotive, viz., the steam engine proper. Any coal steam-locomotive could readily be converted into an "electrothermic" locomotive by simply replacing the fire-box and boiler tubes by a number of parallel electric heating walls running throughout the boiler, and consisting of two copper or iron sheets. It is suggested using in this connection the well known Prometheus heating elements. The consumption of current would depend on the consumption of steam; let the boiler be designed for accommodating 4,000 litres of water, which are to be brought within three hours from 10 to 190° C., corresponding with a steam pressure of 50 kg. per sq. cm.; in the case of an efficiency only as high as 90 per cent., the following data would be obtained: 4,000 litres of water would require, in order to be brought to the above temperature, 4,000 by 180=720,000 kg. cal.; 1 kg. cal.=1,275 eff. wt. hrs.; therefore, 720,000 kg. cal. =about 900 eff. kw. hrs., or distributing this amount over three hours=about 300 kilowatts.

A consumption of steam of 1,000 kilogrammes per hour would accordingly require a supply of current of about 225 kilowatts.

As regards the advantages inherent in the electrothermic system, the resistance of the steam accumulator against current shocks should be mentioned. There is the further advantage of both direct and alternating currents being practicable in this connection, and any desired combination being suitable. The mean efficiency of electrothermic locomotives, being about the same as that of an electromotive machine of the same size, would be about 60 per cent. to 70 per cent., whereas the total efficiency of the railway system, on account of the more advantageous utilisation of the load, would be higher for the former. Furthermore, the adoption of electrothermic service may take place gradually, being much easier than that of electromotive service, on account of the lower cost of the conversion and the easiness with which the personnel may be trained for the new service. A possible conversion of electrothermic into electromotive railway service would finally be readily made, should the electromotive service in future be so improved as to become superior to the electrothermic system.

Rational Modifications in the Design of Marine Engines.

At a recent meeting of the Hamburg section of the *Verein Deutscher Ingenieure*, Mr. Freytag suggested some modifications in the design of marine engines as derived from the progress obtained in designing stationary steam plants. The main requirements would be high figures for the steam tension and the number of revolutions in connection with high linear speeds and strongly superheated steam. These requirements it would not be possible to fulfil without using such governing devices as would exclude any noxious effects of the enormous pressure of superheated steam. Using the slide in this connection would be quite out of the question, whereas the valve, on account of the even distribution of its mass, preventing any noxious effects due to thermic expansion would be quite suitable, the consumption of power being rather low on account of the small resistances. The valve would, moreover, be specially suitable for separating the inlet and outlet, this ensuring a high independency in distributing the steam and choosing the driving device of the distributor. As, moreover, the weight of the valve is quite immaterial as compared with the weight of the slide, there would be no mass and weight effects due to the valve; nor would water shocks be as likely to occur in the case of valve machines as in the case of slide engines. A guided valve distributor of a simple design with safety valve effect and without stuffing boxes, it is pointed out, would best meet modern requirements. Lentz distributors, as well as any analogous designs, would be quite suitable, the coal consumption of machines provided with similar distributors being much less than the one of the usual modern ship engines.

Comparative Tests of Incandescent Gas and Electric Arc Lamps.

The Schuckert and Co. Electric Company, Nürnberg, some time ago, caused comparative tests of incandescent gas and electric arc lights to be made, the results of which have just come to hand. These experiments, as conducted by Dr. Lehmann Richter, gave the following results: The surface luminous intensity at the level of the eye proved fully satisfactory for both light sources, arc light affording also a uniform distribution of light. In the case of electric arc light, no noxious alteration of the air was noted; the temperature would not rise to any appreciable extent, nor would the percentage of carbonic acid be augmented. With incandescent gas light on the other hand, the temperature at the level of the eye was found to rise by about 68° C. in the course of three hours, while the percentage of carbonic acid was found to increase up to a value more than five times the initial figure. As regards the cost of operation of both classes of light, this proved somewhat smaller in the beginning with Auer light, whereas after a short time the figure corresponding to arc light was reached even without taking the lighting flame into account. When accounting for the lighting flame, on the other hand, the cost of Auer light would be higher than that of electric arc light.

Comparative Experiments with Saturated and Moderately Superheated Steam in Locomotives.

In the course of some experiments made on behalf of the Breslau Royal Railway Department, and described in a paper by Mr. Strahl (see *Zeitschrift des Vereins Deutscher Ingenieure*, No. 2), two high-speed train locomotives were fitted with Pielock superheaters, and compared with two similar locomotives

without superheater as to their consumption of water and coal. The main results arrived at may be summarised as follows :—

1. The temperature of the steam on issuing from the superheater being 260°, the saving as to water vaporised was about 16 per cent., and as to the consumption of coal, 12 per cent.; whereas the steam-saving proved equal to about 10 per cent. for a mean steam temperature of 230° in the dome.

2. The consumption of steam in the different locomotives compared, proved the same for equal outputs.

3. The weights of water vaporised are inversely as the specific volumes of the different kinds of steam being directly proportional to the specific weight. The saving in steam obtained corresponded with the increase in the specific volume of the steam due to superheating.

4. The saving in steam, being dependent only on the superheat, must be the same both in compound and single locomotives for equal superheat, the comparison being relative to quite similar locomotives.

5. Slide valves could be used up to the highest temperatures attained (272° C.) provided sufficient oil was supplied to the sliding surfaces by means of lubricating presses.

6. In order to fully utilise the advantage inherent in superheating for a higher efficiency of the locomotive, the cylinders should be increased proportionately to the higher consumption of heat (coal) of the locomotives (in the case of equal outputs) without superheaters, as against locomotives with superheaters.

High-Speed Steam Railway Service.

As an indirect consequence of the Marienfelde-Zossen high-speed electrical railway trials, experiments are being made on a number of German railway lines with a view to investigating the working conditions of a steam railway service with increased speeds. On the Cassel-Hanover line, for instance, the trains tested are made up of gigantic high-speed locomotives and solidly connected six-axle cars, warranting a mean speed as high as 130 kilometres (81 miles) per hour. This speed would enable the journey between Berlin and Hamburg to be completed in about two hours, and it is safe to state that one such train in either direction would be quite sufficient for the present traffic. In the case of these experiments giving satisfactory results, it is thought probable that next summer some specially suitable lines will be arranged for a similar increased speed service, the more so as the Berlin-Zossen trials have shown existing permanent ways (provided they be fitted with heavy rails) to be fully suitable for a similar service. Even in the event of the introduction of electric high-speed railways being postponed for economical reasons, a material improvement in the German high-speed railway service may be anticipated, as far as lines with specially dense traffic are concerned.

Optical Telegraphy.

Our readers will doubtless remember the beautiful experiments in wireless telephony which were made by Herr E. Ruhmer on the Wannsee Lake, near Berlin, last year, and continued with increasing success in the course of last summer. Now the inventor has applied his process to optical *telegraphy*, and the Siemens-Schuckert Werke are just now bringing out this novel wireless telegraphy apparatus.

In optical telegraphy the rays issuing from a projector are, as a rule, intercepted at given intervals, so as to form luminous flashes, succeeding one another more or less rapidly. In the Ruhmer telegraph system, on the contrary, the so-called *speaking arcs* are utilised by superposing on the continuous current circuit of the lamp placed at the sending station in the focus of a projector, a continuous current frequently broken by means of a mechanical interrupter, the opening and closing being ensured by a Morse key, in accordance with ordinary Morse signals. At each closing of the telegraph key the superposed and frequently interrupted continuous current will modify the luminous intensity emanating from the electric arc, giving rise to luminous oscillations which are projected towards the receiving station. If all the conditions be so arranged that the luminous intensity of the lamp is maintained constant, this process will ensure not only a more rapid handing of telegrams, but will permit at the same time of keeping the latter strictly secret, as the human eye, incapable of discerning any more than ten luminous alternations per second, will get the impression of a continuous beam on account of the rapidity with which the luminous oscillations of the transmitting station will succeed each other.

The receiving station is arranged in a way analogous to those of optical telephony, comprising two telephones and one parabolic reflector in the focus of which the selenium cell is placed. The luminous oscillations of the transmitting station are perceived in the telephone of the receiving station by means of the selenium cell as humming intermittent sounds, constituting *acoustical* and directly perceived *Morse signals*. The pitch of this sound will depend on the frequency of the interrupter. Whereas in transmitting language, uncertainties are possible on account of the different acoustical intensities of the different vowels, the same sounds have to be heard here for more or less prolonged intervals. It has therefore been possible to ensure perfectly clear transmissions of signals in atmospheric conditions which would have rendered difficult the transmission of language. The beginning of a communication is indicated by a bell, operated by the selenium cell without the agency of any wire connecting it with the transmitting station.

The satisfactory results of the experiments so far made go to show that this system of optical telegraphy, like the analogous system of optical telephony, will be used to special advantage in the case of transmissions over brief distances. It will, therefore, be especially suitable for military and naval purposes.

The Berlin Telephone System.

According to the latest returns, the number of subscribers to the Berlin telephone system has reached the enormous figure of 73,000. This would mean an increase by about 10,000 in the course of last year. Of the above total, about 11,000 would be relative to the suburbs, Berlin itself being represented by about 62,000, *i.e.* 6,000 subscribers more than last year. The relative increase in the number of subscribers in the Berlin suburbs being about 4,000, is thus much higher. The largest Berlin telephone exchange is the main telephone office, comprising 12,340 connections.

THE MINING WORLD.

BY A. L.

THE world's copper output in 1903 was 589,361 long tons, compared with 551,316 tons in 1902 and 515,992 tons in the previous year.

Colonel K. M. Foss, in a recent interview with a *Times'* correspondent, said he had been working northward of Mergui, in Lower Burma, to the Siamese frontier with engineers, and had discovered the existence of deposits of tin ore equal to those in the Straits Settlements and likely to add largely to the world's output. Excellent coal was also found in the vicinity.

The American Society of Civil Engineers has appointed a Committee to represent the Society at the Universal Exposition to be held at St. Louis in 1904. The Headquarters will be located in the Liberal Arts Building, and the Members of the North of England Institute of Mining and Mechanical Engineers have been cordially invited to avail themselves of the conveniences to be provided during the Exposition. The Society will exhibit a collection of plans, photographs, models, and descriptions of American engineering works, which they have no doubt will prove of great interest, and in addition they intend to make their headquarters a centre of information as to all other exhibits which may be of engineering interest. A register will also be provided, and it is hoped that the headquarters may serve as a rallying point and rendezvous for all visiting engineers.

Electricity in Mines.

Since the last issue of PAGE'S MAGAZINE went to press the report of the Departmental Committee on the use of electricity in mines has been issued as a blue book. As general principles which should govern the employment of electricity in mines they suggest the following:—

(1) The electric plant should always be treated as a source of potential danger; (2) the plant, in the first instance, should be of thoroughly good quality, and so designed as to ensure immunity from danger by shock or fire, and periodical tests should be made to see that this state of efficiency is being maintained; (3) all electrical apparatus should be under the charge of competent persons; (4) all electrical apparatus which may be used when there is a possibility of danger arising from the presence of gas should be so enclosed as to prevent such gas being fired by sparking of the apparatus; when any machine is working, every precaution should be taken to detect the existence of danger, and on the presence of gas being noticed, such machines should be immediately stopped.

General principles are formulated with regard to the application of electricity, in reference to generating stations, cables, switches, fuses, etc., stationary motors, portable motors for coal cutters, drills, etc., electric locomotives, electric lighting, shot-firing, signalling, and electric relighting of safety lamps. It is pointed out that there may be parts of mines in which so much fire-damp is emitted that the introduction of electricity might be improper, notwithstanding the fact that by law these places may be worked with safety lamps. The committee, therefore, emphatically impress on both colliery owners and managers that the ultimate responsibility of installing or using electricity in such places should and must rest with them. A very valuable set of suggested rules is appended.

With regard to the much discussed subject of pressure, the committee considers that a reasonable limit would be medium pressure not in any case to exceed 650 volts. The report is signed by Mr. H. H. S. Cunynghame, C.B. (Chairman), Mr. Charles Fenwick, M.P., Mr. W. W. Hood, Mr. W. H. Patchell, Mr. W. N. Atkinson (H.M. Inspector of Mines), Mr. A. H. Stokes (H.M. Inspector of Mines), and Captain A. Desborough (secretary). It should be of considerable service in dispelling some of the exaggerated notions which have been felt among mine-owners and managers as to the dangers of electricity in mines.

Electric Light for Deep Levels.

A strong plea for the use of electric light in the mines of South Africa was made by Mr. T. L. Carter, a speaker who participated in the discussion which followed a paper on the ventilation of deep levels, read before the Chemical, Metallurgical and Mining Society of South Africa. It was pointed out that the bearing of mine illumination on the ventilation question is an important point to consider. Other things being equal, the illuminant which causes the least vitiation of the atmosphere should be adopted. The old paraffin flare lamp is one of the favourite methods of lighting up the stations. Anyone who has ever worked in a drive with a paraffin flare lamp a few hundred feet from a cross-cut, will have found that in less than a quarter of an hour either he or the lamp had to go out. On some mines acetylene lamps are being used instead of a flare lamp. One of the greatest advantages of electric lights in a mine is that they do not contaminate the mine atmosphere. When possible, therefore, electric light should be installed.

Mining Developments in Korea.

At the present juncture it is interesting to turn to the paper on mining in Korea which was contributed a year ago by Mr. E. J. Speak at a meeting of the Institution of Mining and Metallurgy. Attention was called to it at the time in the columns of PAGE'S MAGAZINE. The author pointed out that Korea was not thrown open to foreigners for mining, with the exception that one subject of each of the Great Powers might enjoy one concession.

The principal terms on which these concessions were granted were that mining supplies might be imported duty free, and that the King should receive 25 per cent. of the profits.

Water is plentiful, except for a short period during the height of the winter. Lumber, mining timbers, and cordwood, though not too plentiful, are cheap owing to the cheap labour, but steps are now being taken to develop a water-power scheme in order to preserve the timber. Labour is generally plentiful, but considerable difficulty is met with in obtaining suitable white foremen and overseers, who are mostly obtained from the Western States under contract, and, as in similar cases all the world over where personal selection is not possible, are not always satisfactory. Japanese are largely employed as carpenters, blacksmiths, and engineers, and many of them are excellent workmen; their wages are mostly three shillings per day, but a few get more. Chinese are largely employed as surface labour in the mills and cyanide works, and to a limited extent underground. They are preferable to Koreans for such employment, as they work more regularly and require less supervision. They are also indirectly useful in preventing labour troubles and checking thieving, as they do not mix with the Koreans. The ordinary wage of a Chinaman is 10½d. per day. Koreans are employed for the rest of the work; their carpenters are expert adze-men, and as miners and tool-sharpeners become very efficient. At a recent drilling contest, the winning double-handed team, using ⅞-in. steel drills, sharpened in the ordinary way, drilled 22 in. in a granite boulder in ten minutes.

Korean Coolie Labour.

The pay of an ordinary Korean coolie is 7½d. per day, and of a miner or carpenter, 1s. 3d. a day. No food or lodging is provided for any of the Oriental workmen. Koreans run most of the hoisting engines and no serious accidents have occurred. After allowance is made for the difficulties of language, it must be said that these Japanese, Manchurians, and Koreans are as intelligent and as capable of receiving instruction as a European would be who had been brought up without knowledge of our methods. Their religious and moral ideas are somewhat crooked, but they are amenable to common-sense. A Korean is not so conservative as a Chinese.

The main principle on which this labour is managed is to have all natives work under the direct supervision of white men without any intermediate native foremen. With proper organisation the number of labourers white man can look after is mainly determined by the extent of ground they are spread over.

The Mining of Corundum.

In the course of his fourth Cantor lecture on the Mining of Non-Metallic Minerals, Mr. Bennett H. Brough confined his attention to precious stones, one of the most interesting sections dealing with Corundum gems. The methods of mining for the ruby in Burma are suited to the three modes of its occurrence in the limestone, in hill detrital material, and in the alluvial deposits in the valleys. In the quarries blasting is unsuitable as it injures the gem stones. The dirt is raised by endless ropes from quarries 50 ft. deep. Stones of greater weight than four carats are of such exceptional occurrence that they command fancy prices. The largest known were brought from Burma in 1875 and weighed 37 and 47 carats respectively. They are said to have been sold for £10,000 and £20,000.

Emery, the common form of corundum, is found in large quantities in the Island of Naxos, and the mines are the property of the Greek Government. The Naxos emery is superior to that of Asia Minor owing to its great density, and the greater fineness and hardness of its grain. It fetches 112 to 115 francs a ton. The world's consumption of emery is 25,000 tons annually, of which Asia Minor supplies some 18,000 tons, valued at £53,000; Canada 388 tons, valued at £10,914; and Naxos 6,328 tons, valued at £26,830.

These lectures, by the way, have been bound up together, and are published by Wm. Trounce, of 10, Gough Square, Fleet Street, E.C.

Mining in China.

In view of the enormous mineral resources of China and the equally enormous supply of labour, it is impossible to avoid the conclusion that this much-disputed region is destined to play a most important part in future mining developments. A correspondent of the "Engineering and Mining Journal" lately pointed out that were it not for Government control the antimony mines which are now being worked in China would swamp the market. As it is, prices of refined antimony have been forced down over one-third, and Chinese antimony ores are offered of good quality and at low prices. The mines are worked by hand labour, with crude tools, and no machinery is used. The ores, as brought to the surface, are sorted by women and children, and are broken, where necessary, into small pieces, hand-culled and dressed. In this way the ore for export and for sale is practically pure. The rejected ores are smelted into crude antimony by a primitive method with great waste. The method is by volatilisation, and the slags carry 25 to 30 per cent. metal. Under these conditions, with over 1,000 miles inland transportation, Chinese are able to ship quantities of both ore and regulus at a satisfactory profit. These conditions will probably apply to the working by hand labour of many other minerals, especially if, under practical supervision of foreigners, modern tools and methods of mining are used.

OPENINGS FOR TRADE ABROAD.

Straits Settlements.

A correspondent writes as follows :—

"I shall be much obliged if you will let me know if I can procure a machine for injecting or pumping a deadly gas into the earth, or white ants' mounds, to destroy this pest. Termites (white ants) generally live in mounds about 1 ft. or 2 ft. below the surface of the earth. A hole might be made in the spot with an iron bar of, say, 1½ in. diameter, then a hollow tube perforated at the end put in and the gas pumped into the earth. I shall be much obliged for the above information and the cost of the machine and the gas."

Spain.

Tenders, which should be delivered before March 14th at the Secretariat of the port works of Castellon, are in demand for the supply of a locomotive and tender, suitable for a gauge of 1·30 metres, with three pairs of wheels coupled, and of a maximum running weight of 22,500 kilogs. A provisional deposit of 2,000 pesetas, or about £63, is required to qualify any tender.

An opening occurs in the Municipality of Valencia de Alcantara, for the work of supplying and laying iron tubing to replace the existing aqueduct which brings the water supply into the said towns. Upon adjudication of the contract, the contractor has to deposit the sum of 5,000 pesetas, or about £150.

Tenders are in demand which will be opened on the 6th April next in the Ministry of Public Works, Madrid, for the concession to construct and work for sixty years a steam tramway in Valencia, from a station in that city to the port of Valencia.

Concessions have been granted for a metre-gauge railway from Barcelona to Junquera *viâ* Palamos, with the following possible branch lines: From San Adrian de Besos to connect with the narrow gauge line from Igualda to Martorell and with the tramway from Manresa to Berga; from Lloret de Mar, to connect with the narrow gauge line from Olot to Gerona; and from Vilamalla to Rosas and Olot. Also a narrow gauge line from Berja to Ugijar, passing through Alcolea and Cherin, with a branch to Canjayar.

Russia.

There is a steadily growing demand for bicycles and motor cars. In the latter case, the trade has developed surprisingly in the space of a few months. Manufacturers must bear in mind that, owing to the roads, machines must be of the most solid type, and in order to compete with cheap German and Belgian makers, a depôt in Odessa, where detached parts could be put together, would be of the greatest service, as the duty on manufactured machines is, proportionately, much heavier than that on parts.

Canada.

The present year promises an active development of telephone competition in Canada. Several of the larger cities of Ontario will have before them application for franchises to compete with the Bell Telephone Company. It is reported that a company have recently obtained a Dominion charter, and propose to build exchanges and construct long-distance lines throughout Canada in competition with the Bell Company.

Australian Commonwealth.

We learn from the Canadian Commercial Agent at Sydney that in the Australian markets there should be a good opening for heating apparatus, particularly in churches, schools, and shops, beyond the coast line, and there is no doubt that a manufacturer of heating apparatus would find a good trade. It would be necessary to send out an expert in hot air and hot water, and open a warehouse; though this need not be an expensive one, it would require considerable capital to do the business profitably.

He also reports the extraordinary success of artificial irrigation on comparatively small areas of land, and predicts for it a great future. The prospects for selling pumping machinery, motors, and other power generators—as, for instance, windmills and steam, oil, and hot-air machinery—are very good. It would be advisable to sell such machinery through agents who understand how to put it up. Some firms that sell that class of machinery for certain manufacturers could be induced to deal in new ones, if good and cheap. It would be necessary to send a competent expert and put up some sample machines, in order to prove their efficiency.

Natal.

The Government of Natal is prepared to receive tenders for the supply, erection, and completion of plant capable of dealing with 4,000 tons of coal in ten hours, consisting of one fixed and two movable appliances to discharge into ships' hatches direct from trucks, or from storage bins of 10,000 tons capacity. Also plant capable of emptying trucks and delivering 800 tons of coal per hour from four mechanical appliances, each designed to deliver the coal into ships' coaling ports, or into hatches on deck for a single line of ships up to 50 ft. beam, or, alternatively, up to a distance of 70 ft. from the wharf face, so as to serve a double line of ships.

Mexico.

A contract has been arranged between the State and Messrs. Pedro Ruiz y Manuel L. de Guevara for the construction and working for ninety-nine years of a railway in the State of Vera Cruz, from a point of the Estero de Santecomapan, to Caleria, Canton of los Tuxtlas, to be called the Tuxtlas and Golfo S. A. Railway, with the right to prolong the line to San Andres and Santiago Tuxtla. The gauge is to be 914 millimetres. The free import of materials and goods referred to in Article 74 of the Railway Law will be allowed for three years.

Brazil.

The Budget for the present year authorises the Executive to carry out the construction of the Port of Belem, adopting the plans suitable for the portions which have to be constructed between the bridge of the naval arsenal and the Port of Pinheiro.

The Government has been authorised to construct a railway from Timbó, in the State of Bahia, to the city of Propria, in the State of Sergipé. This railway is to join the cities of Aracajú and Simao Dias directly or by the means of branches.

A decree has been published approving the estimate of 2,722,107 milreis, or about £136,105, for the construction of the works of the first 60 kilometres which constitute the first section of the extension of the Central Railway of Brazil, between Curvello and the San Francisco River.

WHAT OUR TECHNICAL COLLEGES ARE DOING.

BY A TECHNICAL STUDENT.

TECHNICAL EDUCATION AT DERBY.

FROM the Principal of the Municipal Technical College of the Borough of Derby, Professor F. W. Shurlock, B.A., B.Sc., we have received an imposing list of successes obtained during the session 1902–3, together with the calendar of the college. The half-tone illustrations give an excellent idea of the practical work carried on at the college, and some of them make one envy the students at Derby, who are evidently so well looked after.

AT LIVERPOOL UNIVERSITY.

The work carried on by the Faculty of Engineering of the University of Liverpool, under Professor H. S. Hele-Shaw, LL.D., F.R.S., M.Inst.C.E., is set forth in an interesting pamphlet with plans and views of the main workshop and Walker engineering laboratories. Particulars are given of a number of valuable institutions. The examination for university scholarships takes place in May. Every scholar will be required to register as a student of the university, and to attend not less than four day lecture-courses in every term, unless the Senate expressly approve a smaller number of attendances.

MR. BRADLEY'S SUCCESS.

I referred last month to the fact that an Institution of Mining and Metallurgy Research Scholarship of £50 had been awarded to Mr. R. S. Bradley. Mr. Bradley has been investigating the structure and behaviour of cast irons in the metallurgical laboratory of King's College, which is very well equipped for micro-photographic work. Although much is being done in this direction in the study of steel, very little attention has been paid to cast irons.

Mr. Bradley has recently established a laboratory at his father's foundry at Newark for chemical and micro-photographic examinations, and we understand he has already reaped considerable practical benefit from it.

BIRMINGHAM UNIVERSITY ENGINEERING SOCIETY.

Reviewing the progress of this society during the past seven years, Professor F. W. Burstall, M.A., M.Inst.C.E., president, remarked that during the first session there were but few papers written by students; even the discussions were, for the most part, confined to the older members of the society. Gradually, by slow development, the students took a larger and larger part not only in the papers, but in the government of the society. For his own part he considered the greatest thing that he had done to promote the usefulness of the society had been to abstain, as far as possible, from any interference with the methods of the students. He had always thought that for these college societies to be of real service in training students to think for themselves, the staff should not take a very prominent part in the government. Such treatment was likely to leave the students as helpless at the end of their course as they were in the beginning. The past three years had, he considered, shown a very great advance on the preceding time. The inauguration of the journal—the first of its kind in this country—was a sign that the Engineering Society was not content to stand still, but wished to advance in all directions which were likely to be of benefit to its members. At the present moment they were in a most prosperous condition, due almost entirely to the activity of those students responsible for conducting the affairs of the society and the journal.

THE ROYAL COLLEGE OF SCIENCE.

The prospectus of the Royal College of Science and Royal School of Mines, makes a volume of 218 pages, packed with useful information. It is to be noted that application for the admission of students in the session commencing in October must be made on a specified form, and sent to the Registrar before the middle of June. In this form a statement is to be given of the studies which the applicant has already pursued, the examinations he has passed, and the names of a teacher or teachers to whom reference may be made. This application will be considered by the Dean and Council of the college, who will decide whether or not the candidates can be admitted.

Students must be free from organic disease and physical defect that would interfere with their studies, and a medical certificate to this effect may be required.

It is further pointed out that without some preliminary knowledge of mathematics, mechanics, chemistry, and physics, it is not possible for students to follow the courses with advantage. No fee-paying student will be entered for the Associateship Course unless he has obtained a First Class in the first stage of mathematics, or the first stage of practical mathematics; and in the first stage of practical plane and solid geometry, theoretical mechanics (solids), theoretical mechanics (fluids), inorganic chemistry (theoretical), sound, light, and heat, and magnetism and electricity, or a pass in some higher stage of those subjects at the Examinations of the Board of Education, or can show to the satisfaction of the Council of the College, by having passed the Examinations of other recognised institutions or examining bodies, that he possesses the necessary elementary knowledge of those subjects, while for occasional students who desire only to take up certain specific branches of science some preliminary knowledge of such subjects will be required.

Admission is granted to persons desirous of attending certain courses of the lectures without the laboratory instruction, on payment of the lecture fees. Associates of the Royal College of Science or of the Royal School of Mines have the privilege of free admission to the Library and to all the courses of lectures.

THE TREASURY GRANT TO UNIVERSITY COLLEGES.

A deputation introduced by Sir Oliver Lodge and representing the University Colleges of London, Manchester, Liverpool, Leeds, Birmingham, Nottingham, Bristol, Newcastle, Dundee and Sheffield, recently waited on the Chancellor of the Exchequer to point out the necessity of an increase in the present annual Treasury grant of £27,000 to University Colleges. We note that Mr. Austen Chamberlain will recommend that the vote be doubled for the present year, and that he hopes next year it may be increased to £100,000. It is obvious that the amount now set aside by the Treasury is quite inadequate for the maintenance of these institutions, and there are probably few directions in which the national funds could be better expended.

NOTABLE BRITISH PAPERS.

A Monthly Review of the leading Papers read before the various Engineering and Technical Institutions of Great Britain.

THE TREND OF MODERN INVENTION.

THE Junior Institution of Engineers received from their President Mr. J. Fletcher Moulton, K.C., F.R.S., M.P., a most instructive and suggestive address on "Invention." Incidentally he asked "In what direction is invention tending?" Here is the reply:—

In two directions which are well-nigh opposite or I ought rather to say complementary the one to the other. On the one hand the tendency is to divide manufacture up into many simple operations, each capable of being performed swiftly and well by a special machine designed solely for that purpose, and thus working under the most favourable circumstances for cheapness of production. Take for example the manufacture of machine-made watches—a manufacture which I am happy to say, is at last being vigorously taken up in England, after we have so long allowed ourselves to be distanced by our foreign competitors, both commercially and inventively. Each machine employed has only a minute operation for its share of the work, several being needed to perfect each piece. But these machines are so nearly automatic that the labour required for the most part needs no skill, and the rapidity with which they work makes the actual cost of production almost incredibly small, while the accuracy of the workmanship can be, and is, brought up to a pitch which completely satisfies all requirements of practical use. This tendency to subdivide the operations of the production until they are each capable of being performed either automatically or with unskilled labour, is having momentous effects in labour questions. Strangely to say, increase in accuracy of workmanship is tending to increase the demand for unskilled labour. The skill which used to be sought for in the workman is now embodied in the machine. This is due to what I may term the uniformity of mankind. The chief wants of each class are common to all the individuals that form it. Hence any rise in the standard of comfort of a nation produces a demand for millions of articles of one and the same kind, precisely such a demand as can best be satisfied by the unvarying but economical production of machines of the type of which I have spoken. I have no doubt that the growth of production as a whole will be so rapid that the total demand for skilled labour of all sorts in manufacture will not actually diminish, but I am equally sure that relatively to substantially unskilled labour, it will grow less and less. Rough and brutalising labour will no doubt be done away with, but its place will be taken by unskilled, rather than skilled labour.

For you must remember that precisely that same process of "coding" is being applied to bring each operation in production within the reach of unskilled labour. Take for example the machines that are used in domestic or trade life (such as typewriters, sewing machines, etc.), and which are produced in such vast numbers. Inventors are hard at work modifying the construction or configuration of each piece of these machines so as to lessen the cost of its production by enabling it to be made by some cheap process which dispenses with hand work and skilled labour. I have known a company in the United States, before they sold a single machine, spend two years and £20,000 in modifying the parts and their arrangement till each could be made by stamping or some similarly cheap method at a minimum of cost. And you must not forget that if wisely done this relegation to automatic machines and unskilled labour is an advantage to the public, because it brings with it as a consequence that absolute interchangeability of parts, which diminishes so vastly the cost of repairs.

Side by side with this tendency towards highly-specialised machines, each doing one small and separate operation, there is the other line of invention, *i.e.*, of machines which combine—I would prefer to use the mathematical term, "integrate"—a whole series of successive operations and turn out a completed article. Here we find perhaps the greatest inventive triumph of our time. Take for instance the linotype: Type-setting, type-founding, and casting blocks of type as in stereotyping, had all been done by hand, and to some extent had been done mechanically, before the linotype came in. But it united them all in one machine, and enabled an operator, with little greater labour than in working a typewriter, to produce the set-up type cast in lines ready for printing.

It is difficult to say which class of machine is attracting most attention at the present moment—whether combination or division of operations, synthesis, or analysis, is taking the lead. If success is completely attained, the machine that combines in itself the whole series must always gain the day. But the penalty for falling short of perfection is heavier, and the danger greater. Each step brings its own liability to failure and the failure of a step has more serious and more far-reaching consequences. Yet we have abundant proofs on all sides of us that human ingenuity is equal even to this task. Here again the effects of the systematic pursuit of invention in the United States show themselves markedly. Few private inventors have, unaided, the means or the time to work out these complex problems. Mergenthaler, the inventor of the linotype, spent years of incessant labour before he came to a practical result. Plan after plan was devised by him only to be rejected, because the success it brought was too incomplete. At last he succeeded, and he and those who had supported him had their rich and deserved reward.

POINTS ON FORCED DRAUGHT.

AT a recent meeting of the Staffordshire Iron and Steel Institute, Mr. R. B. Hodgson, A.M.I.M.E., contributed a paper, the object of which was to demonstrate that a properly designed forced draught furnace provides the means by which steam boilers can be most economically worked. To prove this, the author first considered the composition of fuel from its chemical and scientific aspect. He then proceeded to discuss the subject from a practical point of view, the paper containing many suggestions valuable for steam users. We quote the following :—

Under a good system of forced draught several advantages will follow :—

1. The working of the furnace will be entirely independent of both wind and weather.

2. There will be practically no loss through leaky brickwork.

3. The blast can be so regulated that no cold air need be drawn through the fire-doors when they are opened for cleaning, or otherwise attending to the fires, so that the heating surfaces may be kept at a more uniform temperature.

4. The firegrate may be reduced in area and the fire thereby concentrated, by which means the large excess of air over the theoretical quantity required for combustion, may be very materially reduced, with a resultant higher and more even temperature, and a consequent greater proportionate evaporation.

5. The heat of combustion will be available down to a much lower temperature than could be the case under natural draught. By the use of feed-water heaters, otherwise known as economisers, and increasing the number of economiser pipes, and by partially closing the dampers, the heated gases may be kept in contact with the boiler and its flues for a longer interval, and consequently enter the chimney much reduced in temperature.

6. The lower grade fuels, that can only be burned with difficulty under natural chimney draught, can be efficiently burned under forced draught.

7. Refuse fuels, such as coke dust, coal dust, pan breeze, spent tan, sawdust, ashpit refuse from puddling and reheating furnaces, and muffles, which it would be impossible to burn under chimney draught, may be burned with ease by forced draught, the higher rate of combustion compensating for the lower evaporating value of these fuels.

8. The evaporation under forced draught can be increased according to other conditions from 20 per cent. to 50 per cent. without loss of fuel efficiency.

FORCED DRAUGHT IN OPERATION.

It is interesting to review the action of a boiler furnace working under an efficient system of forced draught. In this case the fire-door, which neither contains hole nor grid, is made an air-tight fit by being suitably machined. The ashpit is closed by a special casting, which carries a pair of cast-iron blower tubes, about 4 in. internal diameter. At the front end a steam nozzle is fixed, through which a jet of superheated steam issues ; this jet of steam causes a current of air to pass along the tube, and by this means any required air pressure may be maintained under the fire-bars. The fire-bars have narrow air spaces, from one-sixteenth inch to one-eighth inch apart. The bars themselves being narrow, a large number of air spaces are thereby provided, through which the air passes, the pressure in the ashpit forcing the air through these narrow air spaces. Should the fire-door be opened before the steam jets have been turned off, the flame will come out of the furnace towards the fireman, and it will be noticed there is no "dip" in the furnace, but that the flame passes straight up from the fuel to the crown of the furnace. The action of the steam and air upon the bars keeps them perfectly cool, so that the clinker does not stick, consequently the fire-bars last much longer than would be the case if the furnaces were worked by either natural or induced draught.

In the methods of smoke prevention under forced draught, it is common to find instances of the grid in fire door combined with a closed ashpit, a bad practice which encourages currents of cold air to pass through the fire door the same as is the case with natural draught.

In the "Meldrum" system this difficulty is overcome by introducing a valvular dead-plate in the place of an ordinary dead-plate. When a furnace has been charged, and smoke is noticed issuing from the chimney, the valve is opened, and since this valve communicates with the ashpit, a thin stream of secondary air, at the pressure and temperature of the ashpit, is admitted over the fire at the front portion of the furnace tube, and has the effect of holding back green gases given off from the newly-fed fuel for a minute or so. Meanwhile, the full pressure of the forced draught is acting on the back portion of the furnace grate, consequently a brighter fire is generated and hotter gases are given off. So that when the valvular dead-plate is closed the green gases, in passing over the incandescent body of fire on the back of the grate, take fire, instead of passing away unconsumed. The valve may be opened to various widths according to the requirements of the furnace, a lever and rod being supplied for this purpose, and being in many instances automatic. That the smoke nuisance is overcome by these means is unquestionable. Some of the very worst known cases in this country have been cured in this way, and anyone who cares to take the trouble to test a furnace fitted up on these lines will find that a chimney giving off volumes of black smoke can be completely cured in about thirty seconds by opening the valve.

CORRECT FORM OF BLOWER TUBES AND NOZZLES.

A word or two is needed with reference to the form of blowers, since so many people imagine that so long as a steam jet is inserted into a pipe the desired end is accomplished ; but this is only true if economy of steam and pressure of air are no object, and frequently steam jet blowers have been condemned through the wastefulness of badly-designed, cheap, and rubbishing apparatus. The proper form of blower tube is the outcome of long and careful experiments, some thousands of tests having been made with the blowers of all shapes and nozzles of all kinds, and the proportion of a modern blower and nozzle cannot be materially departed from without great loss of efficiency. With a correctly-designed and proportioned blower the amount of steam used is generally 3 per cent. of the total evaporation of the boiler.

MEANING OF THE TERM "FORCED."

As some misunderstanding seems to have been created in the minds of many steam users, it will perhaps be as well if I mention two points and give the explanations. First—The term "Forced," as applied to boiler practice, is supposed to mean forcing the boiler. This fallacy is readily removed as one becomes familiar with the subject ; forcing a fire does not necessarily mean forcing the boiler. A natural draught furnace depends upon the difference in the specific gravity due to the difference in temperature between the columns of hot gases in the chimney and a corresponding column of the external air, consequently the draught must vary to some extent with the state of the atmosphere, humid or bright weather

altering the conditions considerably. A strong wind blowing from the ashpit will sometimes necessitate the continual rousing of the fires to the discomfort of the fireman, as well as entailing a great waste of fuel. It must, therefore, be understood that forced draught is the term introduced to distinguish the draught provided by mechanical means—either steam jet, or fan to force air through the fire-bars—and not to force the boiler.

AIR SUPPLY.

The second matter that does not appear to be clear to the steam user's mind, is regarding the air supply. Steam users naturally think forced draught gives a greater supply of air, on account of forced draught being stated as the means of accelerating combustion. This is a great mistake, forced draught given in a proper form provides less air than natural draught; the necessary air for complete combustion is given at a greater velocity but through a smaller opening, because the ashpit is closed and the air supply comes through a pair of blower tubes. Taking for example a boiler with flues 30 in. in diameter, say under natural draught, we have the flue opening as ashpit; here we have, taking the two ashpits, an area of ashpit opening equal to 353·43 square inch, whereas the two 30-in. flues with forced draught will have four 4-in. tubes=50·2656 square inches opening for the air passage, about 1 to 7. The air being carried up the tubes at a high velocity, creates a pressure in the closed ashpit, and the air under pressure escaping through the multitude of spaces between the fire-bars results in a thorough mixing of the air and the gases given off from the burning fuel. This is the principal reason why it is possible to work with so much less air supply under forced draught, than if natural or induced draught were used on the same boiler.

I have been continually asked by engineers and steam users whether boilers working with forced draught wear out more rapidly than boilers working under natural draught? Many think that they do, and the idea is often engendered by the effects of crude attempts to use forced draught, and also by defective boiler design. This is undoubtedly a very erroneous idea, in fact the boot is upon the other leg. Experience proves that boilers are less injured by a properly applied forced draught, owing to the greater uniformity of temperature maintained in the boiler, furnaces, and combustion chambers, sudden alterations of heat and cold having most injurious effects on the interior parts of steam boilers. The principal way in which boilers are injured is by expansion and contraction of the flues, consequent upon the varying heat of the fire.

TURBINES FOR LOW FALLS.

At the ordinary meeting on Tuesday, 16th February, Sir William White, K.C.B., President, in the chair, the paper read was "The Forms of Turbines most suitable for Low Falls," by Alphonse Steiger, M.Inst.C.E. The following is an abstract of the Paper:—

The author draws attention in the first instance to the character of water powers with low falls. These are seldom constant, and in most cases both the fall and the water supply vary. The variations present a difficulty to the proper utilisation of such power, which, however, can be surmounted.

The prejudice against the utilisation of water power with low falls, which constitute the majority of water powers of the British Isles, arises principally out of the disregard of their peculiarities and the want of knowledge of the results which may be obtained from a specially adapted turbine under varying conditions, and is traceable to many unsatisfactory installations of absolutely unsuitable turbines.

The author then considers the difference between impulse turbines and pressure turbines, showing by a diagram that varying the portion of the fall used for producing a pressure, that is, varying the degree of re-action, affords a means of adapting turbines to special requirements.

Pure impulse turbines are not altogether condemned for low falls, but places in which they are preferable to pressure turbines are extremely few in this country, and even the Haenel turbine, which is an intermediate type between the two, is not often suitable. An instance is given in order to show that such turbines, though excellent in themselves and efficient, do not necessarily make a satisfactory installation. The author then shows how the disadvantage of all axial-flow turbines, namely, the influence of the angles of vanes varying with the radial width, which is particularly serious in impulse turbines, is partially overcome.

THE JONVAL TURBINE.

The parallel-flow pressure turbine, generally known as the Jonval turbine, is mentioned as particularly adapted to greatly fluctuating falls, under which a constant speed may be obtained without sacrifice of efficiency. Such a turbine is described, which the author has installed for a fall of 2 ft., and particulars of tests, made with similar turbines at the Zürich Waterworks, are given, to show that the part-gate efficiency of parallel-flow pressure turbines of this kind is extremely good.

It is characteristic of the large majority of re-action or pressure turbines that their part-gate efficiency is low, particularly so at less than half-gate, which renders them valueess for varying conditions; but as in Europe the water-powers to be dealt with are chiefly of this kind, some European turbine-builders have succeeded in designing pressure turbines which are giving a very satisfactory efficiency even at quarter-gate.

OTHER DEVELOPMENTS.

The demands of the generation of electricity by water-power, such as high speed, rapid regulation, and concentration of large power in one unit, have influenced very considerably the art of building turbines. In the first place, the desire for high speeds has led to a more general adoption of radial-flow turbines, of which the inward-flow type is preferable, being the more efficient.

An example of radial-outward-flow turbines is cited, giving the special reasons which have led to their adoption in one case of a relatively low fall, and the manner in which a quite satisfactory efficiency was obtained from this otherwise less efficient type. One new type, the cone turbine, is referred to as taking the place of the so-called "mixed-flow turbines," with a view to obtain a high speed under low falls, even for large units.

CONSTRUCTION OF THE GATE.

One important factor in turbines is the construction of the gate, and it is shown in the paper that a distinction must be drawn between gates intended for adjustment of the turbine to a varying load, where a high part-gate efficiency is of less importance than rapid regulation, and gates for adapting a turbine to varying conditions, where a good part-gate efficiency is an essential condition.

Itself, with special regard to electrical requirements, reference is made to the arrangement of several wheels on one common turbine shaft, vertical or horizontal, giving a few instances of the vertical arrangement which, under certain circumstances, is particularly advantageous, as the weight revolving on the footstep can be entirely balanced, and so the loss of power by friction is reduced almost to nil.

The necessity of placing the footstep of a turbine in an accessible position is alluded to, and the two kinds of overhead footsteps most commonly used are illustrated.

The paper concludes by drawing attention to the necessity of studying more closely the conditions of water-powers with low falls, and of paying greater attention to more careful adaptation of turbines to each fall, which would probably lead to a better appreciation of the water-powers of this country.

TUNNELLING UNDER LAKE SUPERIOR.

AT a recent meeting of the Institution of Mining and Metallurgy, Mr. P. R. Robert, gave a most interesting account of some difficult tunnelling operations under Lake Superior, which were carried out in order to supply water to stamp mills in the Lake Superior copper region.

The stamping mills in this region generally contain from three to six heads each, and it is found that about thirty tons of water are required per ton of ore treated, the tendency nowadays being to increase rather than fall below that quantity. Owing to this demand for an abundant supply of water, the mills are located on the shore of the lake, though the disposal of the tailings is likewise a factor which has to be taken into serious consideration in determining the best position for them.

In the neighbourhood of the intake tunnel, described, there are five mills having twenty-one steam stamps with a daily crushing capacity of 9,500 tons.

In the case of the Adventure mill, the lower end of the mill and the pumping engine-house are 98 ft. from the lake. The lake shore faces north and is thus exposed to full force of the prevailing northerly winds and which are often very severe.

The shore consists of sandstone, which at the shore line rises to a height of 17 ft. above the lake. The lake bottom is also of sandstone and falls to the north with an inclination of about 2·6 in 100. The actual dip of the sandstone strata toward the north was not determined; it is probably about 20°. Along the shore there is much sand, but the lake bottom itself is nearly free from it. In winter time, when the wind is from the north, much floating ice is seen along shore, extending out for fully 200 ft. in hummocks as high as 20 ft. above lake level. This ice remains stationary until spring, when it melts away. In the fall, during storms, much vegetable matter is seen in suspension, such as leaves, water-logged wood, bark, etc., even as far out as 250 ft. from the shore.

The requirements of the mill were :—

(1) A full supply of water throughout the year.

(2) Absence of sand in the water.

(3) Possibility of increased supply in the event of the plant being enlarged.

To meet these requirements it was decided to sink a shaft on the shore, drive out a tunnel under the lake and let the water into the tunnel through holes bored into the bottom of the lake.

A shaft, 8 ft. by 10 ft., was started midway between the pump house and the lake, and sunk in the sandstone to a depth of 93 ft. The bottom of the shaft was made to converge to a point with the object of being able to extract by a sand pump any sand which might accumulate there.

The shaft was sunk by contract at $11 per ft. for labour and supplies.

At 81 ft. from the surface a tunnel 7 ft. by 5 ft. was started; it was driven by four men, two in a shift, using a Rand drill (No. 3 B) with the cylinder $3\frac{1}{4}$ in. diameter. The progress was, usually, about 150 ft. per month. The contract price for labour and supplies, not including tramming, was $5·10 per foot. The tunnel was driven for a total length of 887 ft. At first the amount of water percolating into it did not exceed fifty gallons per minute; but at a distance of 610 ft. a seam of white sandstone was cut which let in water freely. It appeared to be the prolongation of a similar seam which was cut in the shaft, 42 ft. below the surface.

After passing this seam the water in the drift increased considerably, until, at 825 ft., the inflow was 225 gallons per minute, and finally, at 887 ft., 350 gallons per minute. At this point a chamber was cut, 15 ft. long by 14 ft. wide and 9 ft. high.

The gradient of the tunnel was 6·76 in. per 100 ft. Immediately above the chamber the water was 22 ft. deep, leaving $25\frac{1}{2}$ ft. between the bottom of the lake and the top of the chamber.

It was originally intended to drive the tunnel considerably further, to a point where the water would be deeper and the interval between the lake bottom and the tunnel less; but, in view of the extra expense and time which would have been required, it was eventually decided to stop the tunnel at the point already mentioned.

The writer intended to have ascertained the temperature of the rock at the extreme end of the tunnel, but the rapid inflow of the lake water prevented his doing it. On August 25th the temperature of the air in the end of the tunnel was 48° F.; at the same time the temperature of the water in the tunnel was 42° F.; whilst the temperature of the outside air was 74° F.

When the tunnel was completed boreholes had to be put down in the bed of the lake to let water into the chamber. The holes were bored by a Rand drill (Little Giant No. 7), with a cylinder $5\frac{1}{4}$ in. in diameter.

The drill was mounted on a frame standing on the deck of a scow or barge. The frame was similar to that of a pile-driving derrick, and projected over the side of the scow. The drill was arranged so as to slide in guides, and it could be raised or lowered by means of a small steam winch on the scow. Before the inlet holes were bored, four holes, each 2 in. in diameter and $4\frac{1}{2}$ ft. deep, were bored in the lake bottom at points about 125 ft. from each corner of the scow when in position for drilling. In each of the holes was placed a 2 in. eye-bolt, and to each eye-bolt was attached a rope with wooden buoy. These anchor bolts were fixed by a diver and his helper, who had their own plant in a small scow, 18 ft. by 7 ft. by 2 ft. deep. This having been done, the bottom of the lake above the tunnel chamber was carefully cleared of small boulders, etc., and made as level as possible, partly by blasting. A steel plate $\frac{3}{4}$ in. thick was now bolted to the lake bottom immediately over the chamber; it was $14\frac{3}{4}$ ft. by 11 ft., and in it twenty hole

had been bored, 10½ in. in diameter and 36 in. centre to centre.

The services of the scow and a steam tug were now required. The scow, 20 ft. by 80 ft., carried on deck the drill and frame, a 40 h.p. boiler, a small steam winch, a feed pump, and a No. 5 Cameron steam pump to sluice out the holes. Near the corners the scow was provided with eight 8-in. spuds, with iron points, with the object of holding it in position while drilling was going on. The drill was worked by steam. The drill rods were made of steel of 1 in. diameter, in one piece. The drill bits were about 18 in. long, made with a socket into which the drill was fastened by a key.

The holes were started with a 9 in. drill and run down about 8 ft., then an 8½-in. drill was substituted and the last 8 or 9 ft. were bored with an 8 in. drill.

As each hole was finished, a piece of pipe 8 in. in diameter internally and 8 ft. long was placed in it. 5 ft. of each pipe went into the hole, and 3 ft. projected above the plate on the lake bottom, each pipe being held in place by a flanged collar. The collar was fastened to the pipe by a set screw, and the flange was made wide enough to overlap the edges of the 10½-in. hole in the plate. The pipes were provided with strainers having holes 1 in. in diameter.

When drilling, the progress was generally about 2 ft. per hour. The seven last holes sunk in the most favourable season cost at the rate of $30·74 per foot.

This work was commenced so late in the season, and at the approach of winter, that the weather was very uncertain. Interruptions were therefore very frequent. The nearest port was ten miles distant, and very often it was necessary to run for shelter. On one occasion a storm came up so suddenly that the whole plant was very nearly lost, but work was proceeded with, as it was necessary to secure a water supply for two stamps during the winter. Only three holes were bored at that time, and it was estimated that these would furnish a sufficient supply under a head of 10 ft.

The pumping engine, when running to its full capacity at 75 revolutions per minute (48 in. stroke), would deliver 10,500 gallons per minute. With the three 8 in. holes, without the strainers, and two stamps in operation, the pumping engine made forty-five strokes per minute, and lowered the water in the shaft 10 ft.

The following spring seven more holes were drilled, making ten altogether. With three stamps in operation there was scarcely any perceptible lowering of the water in the shaft. The water was taken from the shaft to the pump by a suction pipe 36 in. in diameter, having a strainer with holes ⅜ in. in diameter. The total cost was $32,798·85.

The air for the drill in the tunnel was furnished by a small compressor on shore. There was also there a small steam hoist. Two steam pumps were used in sinking the shaft and driving the tunnel. The large Rand drill was the only machinery bought specially for the purpose, as nearly all the rest was borrowed from the mine and mill plants. The pumps were afterwards transferred to the mill where they were needed. The scow and tug were chartered.

LIGHTSHIPS AND FOG-SIGNALS.

At a meeting of the Institute of Marine Engineers an interesting lecture on "Lightships and Fog-Signals" was delivered by Mr. J. Sparling.

EARLY LIGHTSHIPS.

Mr. Sparling opened his lecture by describing several of the well-known lightvessels that are moored around the coast. The first lightvessel, he said, was moored at the Nore Sand in 1732, and in 1736 another lightship was moored near the Dudgeon Shoal. The vessels were moored by hemp cables, which, owing to constant chafing, occasionally parted during the winter storms. The first lantern constructed to surround the mast o the lightvessel was designed by Mr. Robert Stevenson, the engineer of the Bell Rock lighthouse, in 1807.

Mr. Sparling described at some length the system of fog-signalling adopted on these vessels. The most powerful lights, he remarked, were unavailing in thick fog. In 1873-4 a series of experiments were carried out by the Trinity House, aided by Professor Tyndall and Sir James Douglass, the then engineer of the Trinity House. The information thus gained led to the adoption of sirens on a large scale, and reed signals in positions where a great range was required. Bells of two tons weight and Chinese gongs were at one time used on lightships, but these had been very largely superseded by manual reed horns. Bells were, however, still used at some stations.

At the Eddystone Lighthouse the two bells which were originally fixed on the gallery of the Douglass Tower had been replaced by the more effective gun cotton signal. At stations where reed and siren fog signals were fixed caloric engines of small power were installed, although in some recent instances these caloric engines had been superseded by oil engines of 20 b.h.p., capable of compressing 183 cubic feet of air per minute. With such an engine they employed two sirens of 5 in. diameter, each having a bent head and copper trumpet 6 ft. in diameter at the aperture, the sirens being geared together for the purpose of giving the same note.

The author considered that the fog-signals around our coasts were a matter on which the Corporation of the Trinity House had every reason to be congratulated. The experiments at St. Catherine's in 1901 fully justified the practice that had previously prevailed in the Trinity House service. In the course of the evening descriptions were given of the horns or trumpets designed by Lord Raleigh and others.

It was stated that, as a result of experiments that had been carried out, the Caskets Lighthouse had a 7 in. siren fitted with a 6 ft. mushroom trumpet, whilst the Nash and Whitby Lighthouses were equipped with two 5 in. sirens fitted with Raleigh trumpets.

Many excellent lantern slides were shown by the lecturer, who was accorded a hearty vote of thanks, on the motion of Mr. K. C. Bales.

BOOKS OF THE MONTH.

"THE ADJUSTMENT OF WAGES."

A Study in the Coal and Iron Industries of Great Britain and America. By W. J. Ashley. With four maps. Longmans, Green and Co. 12s. 6d. net.

Intended as a preliminary survey in a very wide field of investigation, these lectures should afford the student an insight into the problems which underlie the adjustment of wages, and, incidentally, the constitution and working of conciliation boards. The coal, iron, and steel industries have been chosen for consideration, primarily on account of their magnitude and the fact that the persons engaged in them number somewhere between an eighth and a ninth of the income-earning population of Great Britain. Moreover, as the largest of industries, they serve to exhibit the complete substitution of collective or corporate bargaining about wages for individual agreement. The lion's share of attention falls to the coal industry, and in Lecture II. some interesting deductions are drawn from a consideration of the various British Boards of Conciliation. An instructive chapter on "Prices and Wages," in which the *raison d'etre* of the sliding scale is carefully explained, is followed by a consideration of general rates and their interpretation, the hours of labour, etc. The fifth lecture is devoted to the American Coal Fields, and Joint Agreements, and a large share of attention is given to the anthracite problem, the author going very fully into the conditions underlying the recent American coal strike. He then proceeds to discuss the network of Boards of Conciliation which cover the whole field of the iron industry, and a large part of the field of the steel industry in Great Britain. It is remarked that all these boards depend for their efficacy on the existence and practical recognition by the employers of strong trades' unions among the men, while throughout the manufactured iron trade (with the exception of the iron founders) as well as in several branches of the steel trade, general rates of wages are determined by sliding scales. That the sliding scale method seems to possess so much vitality in the iron trade, while it has had to be abandoned in name and greatly modified in practice in the coal mining industry, is explained by two circumstances. "In the first place, the 'long-contract' or 'selling-ahead' system, which has always endangered the sliding scale in the coal industry, does not exist at all in the iron and steel trades." "In the second place, there is some reason to believe that combination among the employers has been more successful in 'regulating' prices in the iron than in the coal industry."

Discussing the iron industry of America, the author remarks that American business men are in their way industrial statesmen :—"They will not be content simply to suppress unions again and again ; they will seek an alternative policy. Mr. Schwab's own policy has just been announced as one of profit-sharing ; and he is now carrying through a scheme to facilitate the acquisition of stock in the Steel Corporation by the operatives employed. I am ready to confess that I am not absolutely sure he may not succeed thereby in killing unionism in his particular branch of trade. I hold no brief for unionism. It is not an end in itself, but only the means to an end ; and the end or ends may conceivably be reached in other ways. But I doubt whether the management of the Steel Corporation realises the grave practical difficulties in the way of the permanent success of this alternative policy. The problem is one very largely of business administration—how to deal, with least expenditure of time and energy, with large masses of men engaged in more or less similar work. And I should not be surprised if American business administrators, after desperately fighting unions until they are tired, should suddenly come to terms with the men, and organise 'joint agreements,' with a completeness and with a thoroughness the world has never seen. The critic may object to such an alliance, and talk of the interests of the consumer. But we have so long idolised the consumer, and with such unsatisfactory results, that society may do well to try the experiment of thinking first of the producers—of all the producers."

The final lecture is concerned with the legal position of trades unions. Incidentally, the author remarks that "the law, as stated in the Taff Vale case, is pretty certain to remain for the future ; and unions will in future be responsible for the wrongful acts of their representatives. The real question which demands an answer is, What are wrongful acts? I shall not attempt," he continues, "to disentangle the complexity of the present legal position as formulated in the decisions of the last three or four years. Eminent lawyers are still capable, in the interest of their clients, of making large and positive assertions in court ; but they know very well that in reality the law is at present in a state of great obscurity and uncertainty."

A large section of the volume consists of appendices, invaluable to the student, and comprising rules of Conciliation Boards, joint agreements, report and awards of the Anthracite Coal Strike Commission, etc., etc.

We do not desire to quarrel with the matter or manner of Professor Ashley's volume, but it has occurred to us that in a future edition it may be found desirable to make the work easier of consultation for those who desire to use it as a reference volume. There are four excellent maps dealing with the English and American coalfields.

A number of reviews are unavoidably held over.

OUR DIARY.

January.

22nd.—The Transvaal mineral output for last month included—silver, 31,406 oz.; gold, 288,824 oz.; diamonds, 29,700 carats; coal, 192,784 tons.

23rd.—Lord Inverclyde presides at the dinner of the Institution of Engineers and Shipbuilders in Glasgow.—About 70 per cent. of the white male inhabitants of the Transvaal have signed the petition, which closes to-day, asking the Government to pass law for the importation of Asiatic unskilled labour.

26th.—The general revenue of Cape Colony continues to show a heavy decrease.—The Transvaal Labour Importation Ordinance passes through Committee in the Legislative Council.

28th.—Sir William White, at the annual dinner of the Liverpool Engineering Society, advocates the teaching of naval architecture in the Liverpool University.

29th.—Half-yearly meeting of the Conciliation Board in the North of England iron and steel trade at Newcastle-on-Tyne.

30th.—Contracts for the construction of two battleships for Japanese Navy, signed in London by representatives of the Mikado's Government—one of these is to be built by Messrs. Vickers, Sons and Maxim, the other by Sir W. G. Armstrong, Whitworth and Co.

February.

1st.—Issue of Blue Book on the use of Electricity in Mines.—Mr. David B. Butler, president of the Society of Engineers, delivers his inaugural address at the Royal United Service Institution.—The Lancashire and Yorkshire Railway Company introduce a new series of powerful tank locomotives.

2nd.—A discussion takes place at the meeting of the London County Council with regard to precautions against theatre fires—it is stated that London managers agree to submit their stage fittings to a process which will render them non-inflammable.

4th.—Launch of the battleship *New Zealand*.—The Works Committee of the Mersey Docks and Harbour Board recommend the expenditure of £295,000 for improvements.

6th.—Japan breaks off diplomatic relations with Russia.

7th.—Collapse of a portion of Dove Holes Tunnel on the Midland main line, attributed to the continuous wet weather.—The Federal Steamship Company's tender accepted for a monthly steamship service between New Zealand and the West of England.—Disastrous fire at Baltimore causes loss of employment to fifty thousand people.

8th.—Postponement of the opening of the Great Northern and City Railway, owing to alterations necessary in connection with the signalling arrangements.—First act of war between Japan and Russia.

9th.—In consequence of communications received from the home Government, the Legislative Council in Pretoria decide to postpone taking any steps with regard to the importation of native labour.—The London County Council accept the tender of Messrs. Price and Reeves, London, for the construction of the Rotherhithe Tunnel, amounting to £1,088,484.—An expenditure not exceeding £181,400 for the construction of the fourth section of the enlargement of the northern outfall sewer is sanctioned.

10th.—Lord Carrington presides at a meeting in the Queen's Hall "to protest against the importation of indentured Chinese labour into the Transvaal."—A meeting of persons interested in the Port of London pass a resolution in favour of a scheme for the construction of a barrage across the Thames at Gravesend.

11th.—Wreck of the steamship *Yeoman* at Corcubion.

12th.—Opening of the Automobile Club Exhibition at the Crystal Palace.—The Legislative Council, Pretoria, gives its assent to the Labour Importation Ordinance.—The revenue of the Transvaal for the half-year ending December last amounts to £2,105,062, and the expenditure £2,253,428.—Death of Mr. William Thomas Ansell.—During the week the floating graving dock, illustrated in our November issue, arrived safely at Durban.

13th.—The Engineering Standards Committee issue a statement of the work now in progress under its auspices.—Junior Institution of Engineers hold their annual dinner.

14th.—Opening of the Great Northern and City Railway.

16th.—Ratification of the combination of Scotch steelmakers to maintain prices on a profitable basis.

17th.—An amendment lost in the House of Commons condemning the introduction of Chinese labour into the Transvaal.—Leading members of the commercial community in Johannesburg declare that the slackness of trade is universal, and that unless labour is supplied to the mines further restriction is inevitable, which would mean disaster.

18th.—M. Curie delivers a lecture on radium at the Sorbonne.—An explosion of nitro-glycerine occurs at Messrs. Curtis and Harvey's premises at Cliffe.

19th.—The Civil and Mechanical Engineers Society inspect the tramway tunnel which is being constructed by the London County Council under Kingsway.—The Labour Ordinance promulgated in the Transvaal, but awaits the Royal approval.

20th.—His Majesty the King inspects the Royal Naval College, Osborne, and the Naval Barracks, Portsmouth.—Deposits of tin ore and excellent coal found in Lower Burma.—Opening of the London County Council pumping station, Lot's Road, Chelsea.

NEW CATALOGUES AND TRADE PUBLICATIONS.

John Lang and Sons, Johnstone, near Glasgow, forward an interesting catalogue descriptive of various lathes fitted with Lang's Patent Variable Speed Drive and Automatic Speed-Changing Mechanism. With the former, in sliding, surfacing, and screw-cutting lathes, the correct surface speed may be had for every diameter, however small the variation. With both, in surfacing and boring lathes while surfacing work, the revolutions of spindle automatically increase as the diameter being turned becomes smaller, thus keeping the tool cutting at practically a constant surface speed. It is claimed that these machines constitute a triumph in lathe design.

Chambers, Scott and Co., Motherwell, N.B.—From this company we have received an artistic catalogue of Electric Overhead Travelling Cranes (E.C. No. 1904). The special features of these cranes are set forth as follows: All bearings being bushed, alignment and adjustment are assured. The Standard Crane Crabs have no overhung wheels, and all the gearing is placed between the cheeks, making a very satisfactory arrangement, and giving a neat and compact trolley. In the designs the number of gear reductions is kept as small as possible, and accessibility to all parts and simplicity of construction is aimed at.

Quaker City Rubber Company, 101, Leadenhall Street, E.C.—This company, whose managers for Great Britain are Messrs. Ronald Trist and Co., have issued a pamphlet containing much useful information on the subject of Daniel's P.P.P. Packing. The advantages of this packing have already been referred to in PAGE'S MAGAZINE. We recommend steam users to obtain the pamphlet and investigate the matter for themselves.

Pethick Bros., London and Plymouth.—This firm issues a well-illustrated booklet, with the significant title, "Enough Granite to Build Ten Londons." This is based on the statement of an engineer who was called upon to inspect the Princetown Quarries of Dartmoor, and to report as to their resources. The pamphlet has some admirable illustrations of the principal buildings, works, etc., for which Devonshire granite has been used, all of which are of the greatest interest to engineers.

Lancaster and Tonge, Ltd., are issuing a fourth edition of their well-known "Slate" catalogue. In order to meet the demand for a more compact steam trap, a special 1903 pattern has been designed, and it is prominently illustrated in this catalogue. To show the compactness of the new trap, it may be mentioned that the ¾-in. trap is 9 in. high, 10 in. long, and 5½ in. wide over all. An interesting woodcut shows the cylinders of a compound engine which is fitted with the "Lancaster" metallic packings, pistons, piston valves, steam dryer, and steam traps (1903 patent). The firm is also issuing a pamphlet entitled the "Lancaster" Specialities. It includes many highly favourable opinions from users of the "Lancaster" metallic packings.

W. N. Brunton and Son, of Musselburgh, Scotland, forward a price list of Galvanised Arc Lamp Ropes. It is claimed for these ropes that they are many times more durable than Manilla, and that they neither stretch nor shrink.

C. W. Hunt Company.—From this company we have received a well-illustrated booklet on the Hunt Industrial Railway. In addition to a large number of illustrations showing the varied types of cars, standard and special, built by the company, the booklet contains much valuable information relating to the Industrial Railway not to be found elsewhere.

John Kaye and Sons, Ltd., have issued a new price list for 1904, showing the latest improvements in their oil cans. As all previous price lists are cancelled, the new issue should be obtained and filed for reference.

Thos. Thompson and Co., 35, New Broad Street, E.C., forward a booklet description of Thompson's "Standard Tachometers, with numerous illustrations. The special feature of Amund's new Tachometers are thus set forth: all sliding friction done away with; no oiling of inner mechanism needed; slightest possible wear; extreme sensitiveness even under the shortest and slightest variation of speed; constant reliability; simple, self-contained, and strong design; absence of delicate parts. We note that the firm acts as agents for the Edwards Air Pump Syndicate, Ltd.

Trading and Manufacturing Company, Ltd., are issuing a four-page illustrated description of the T. and M. Individual File, the object of which is to bind loose sheets or pamphlets in readily accessible book form.

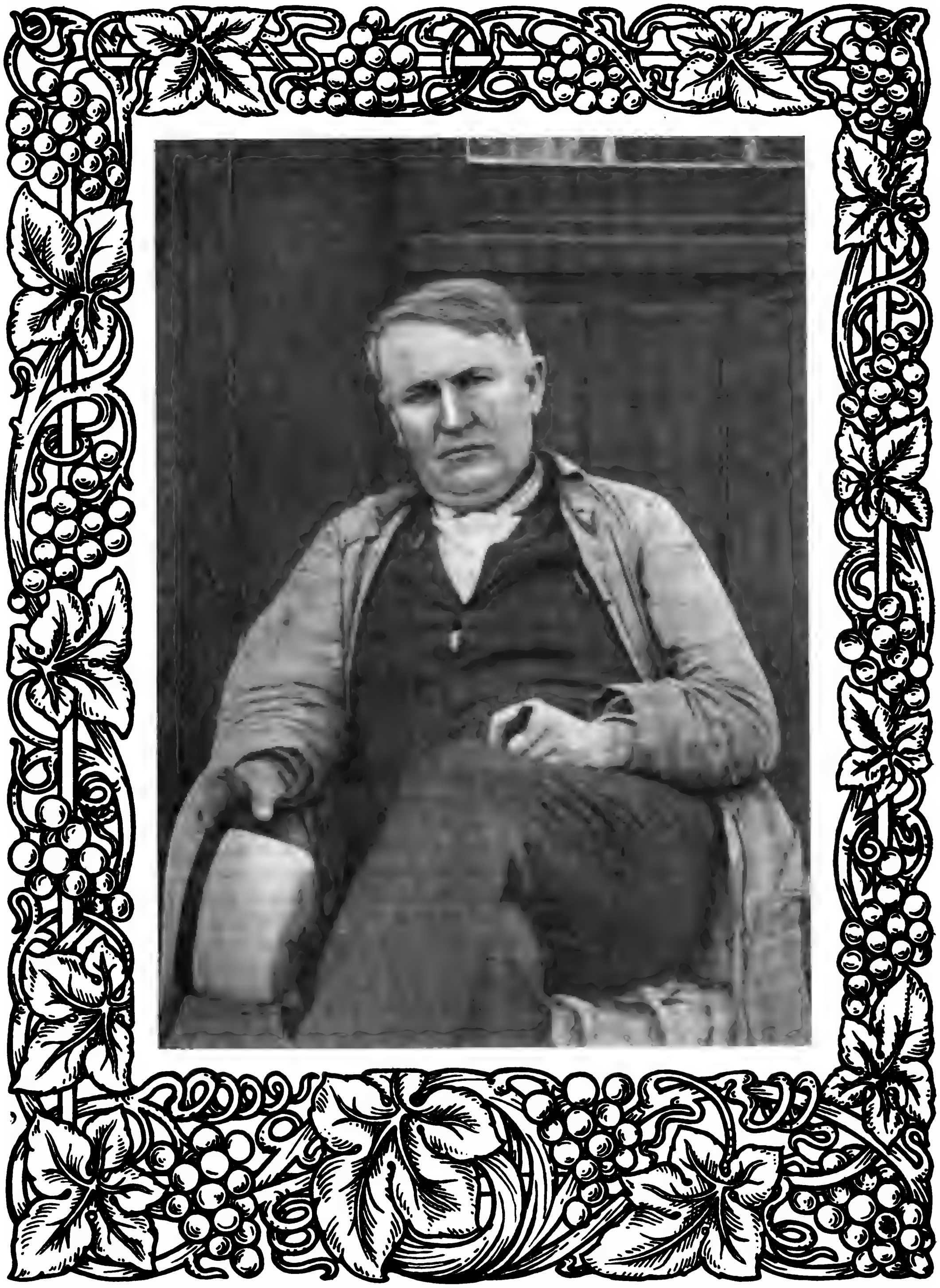
The Cling-Surface Manufacturing Company, of Buffalo, U.S.A., send us a breezy pamphlet on Cling-Surface and Belt Management. This is a production which deserves to be read, if only for the fact that it is well arranged and gets straight to the point.

Empire Typewriter Company, Ltd.—The latest booklet of this Company should be seen by prospective purchasers of typewriters. We note that the price of the regular foolscap model is £12 12s. Irrespective of price the machine has the distinct advantage of visible writing.

Calendars.—We have to acknowledge the receipt of ornamental and useful sheet wall calendars from the Whitman and Barnes Manufacturing Company, of 149, Queen Victoria Street, and W. H. Willcox and Co., Ltd., of 23, Southwark Street, S.E.

Messrs. Lepard and Smiths, Ltd., of 29, King Street Covent Garden, W.C., forward some samples of typewriting paper in white and five tints, with the useful suggestion that these may be identified with different business departments. The paper is certainly pleasant to the eye and seems admirably adapted for its purpose; moreover, we note that it is of British manufacture.

The Worthington Pump Company, Ltd., write that the author of our articles on Birmingham University was under a misapprehension in stating that the cooling tower for circulating water supplied by them was built by a competing firm.



THE LATEST PORTRAIT OF THOMAS ALVA EDISON.

As the dean of the greatest technical school of the world through which the graduates of all other schools must pass, the school of practical experience, and in which school he has eclipsed us all in individual achievement in those arts which tend for the material benefits of his race, do we recognise him, and by these ceremonies honour ourselves in thus honouring and officially perpetuating the name of Thomas Alva Edison.—*Mr. B. J. Arnold, at the Annual Dinner of the American Institute of Electrical Engineers.* (See page 368.)

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining and Allied Industries.

VOL. IV. LONDON, APRIL, 1904. No. 4.

THE HEYSHAM HARBOUR SCHEME.

BY

ARMISTEAD CAY.

A description of the new Midland Railway port which is being rapidly completed at Heysham, near Morecambe. Many of the photographs have been specially taken for this article, and are now reproduced for the first time.—ED.

THE progressiveness of the Midland Railway has rarely been called into question. Unlike some of the other old-established lines it has welcomed improvements and new departures tending to the welfare of passengers before being forced to adopt them by competing lines. Ever since the days of Sir James Allport it has had a reputation for setting the pace, and there is no more striking evidence of the progressive spirit that dictates the policy of the directors to-day than is to be found at Heysham in Morecambe Bay, where the company's new port is now practically an accomplished fact.

Comparatively few people can be aware of the work which has been quietly in progress at Heysham during the last six years; and probably few have realised the imposing scale on which the port has been designed. There is a considerable amount of work still to be done, which will probably require several months, but it is of the nature of equipment only. The project, from an engineering point of view, may be said to be practically complete.

On the occasion of a recent visit, by courtesy of Mr. John Mathieson, general manager of the Midland Railway, the writer had an opportunity of securing special photographs and of making notes on the Heysham scheme. The details of the undertaking were courteously explained by Mr. Baldwin Bent, M.A., M.Inst.C.E., resident engineer.

RATIONALE OF THE SCHEME.

Before discussing engineering details it may be well to devote a brief consideration to the rationale of the scheme, which is the outcome of a determination on the part of the directors to have their own fleet of steamers running between Heysham, the Isle of Man and Ireland. These steamers will be fitted with turbine machinery and in every other respect will meet the modern standard of requirements as regards efficiency and comfort. At the same time, the directors decided to possess their own port and to make such arrangements as would render the running of their steamers independent of the vagaries of the tide, thereby considerably shortening the journey. An important factor connected with this decision is the absorption by the Midland Railway Company of the Belfast and Northern Counties Railway, by an agreement signed in the autumn of 1902.

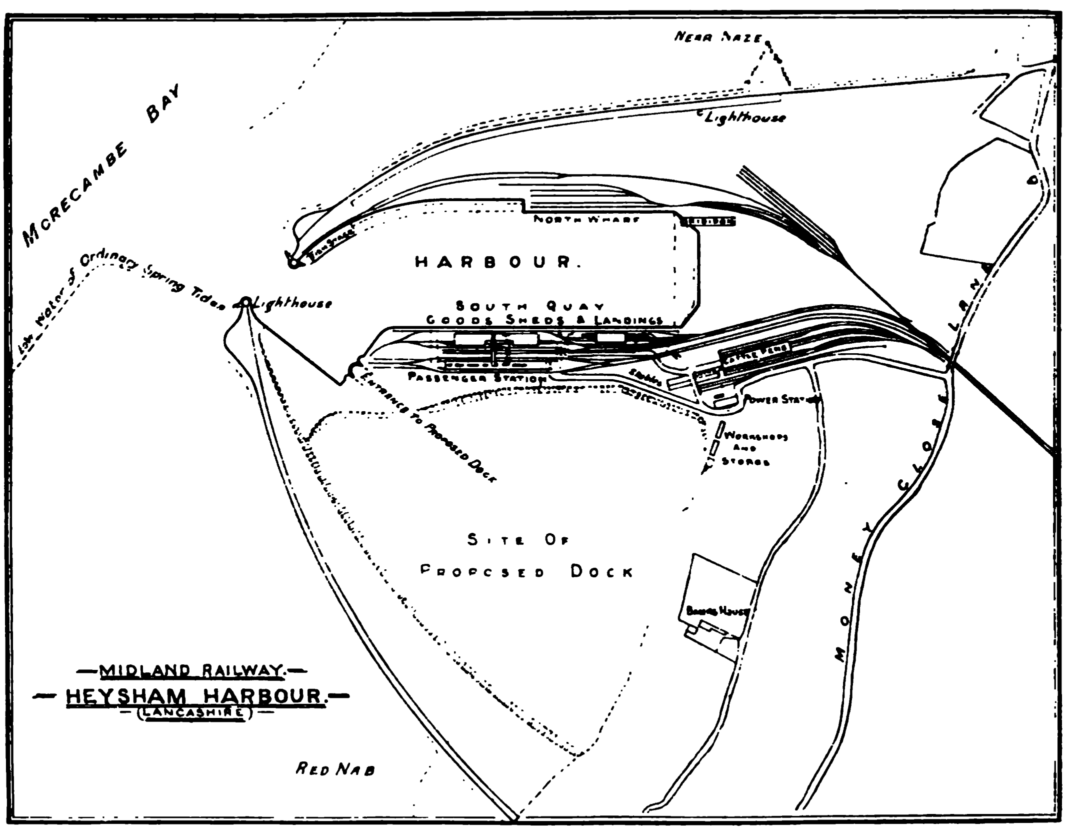
The new steamers will be capable of covering the distance between Heysham and Belfast in 6½ hours. Six journeys to Belfast and back will be made each week, and the same number of journeys to and from Dublin, while twice a week there will be sailings to and from Londonderry. It is anticipated that when the company's arrangements are complete, Belfast will be within 12½ hours of London.

The old stone jetty at Morecambe will no longer be required for shipping purposes, and it is quite possible that it may provide the site for a suitable public improvement. From this pier goods have been shipped for the last fifty years. It was originally built to aid the conveyance of goods from Piel Pier, Barrow, and was subsequently used in the Belfast service for goods and passengers until the transfer of the latter service to Piel Pier. The Londonderry service was next undertaken, and there is also a Dublin service for goods and passengers, the latter having been established sixteen or seventeen years.

THE HEYSHAM SITE.

The site of the new dock offers no features of special geological interest. The underlying rock is of red sandstone which dips towards the sea and is covered with sand to a depth of nearly 30 ft., while underlying the sand in places are beds of stiff boulder clay. In several respects, however, the site is unique. The harbour opens direct into what is known as Heysham Lake—a broad and deep water channel affording direct access to the Irish Sea and thus offering a strong contrast to the Fleetwood Channel, the difficulties of which are well known. Steamers leaving the harbour will only have to negotiate the short channel 900 feet long, from the Roundheads into Heysham Lake, when they can proceed full steam ahead.

Another circumstance favourable to the site is its proximity to the great manufacturing centres of the north. Visitors to Heysham cannot fail to be impressed also with the exceptional opportunity which exists for expansion



THE UPPER PHOTO SHOWS THE LÜBECKER EXCAVATOR AT WORK, TAKING OFF 18 FOOT CUT IN SAND. THE LOWER VIEW ILLUSTRATES PILE DRIVING.—NO. 1 ROUNDHEAD.

A COMPREHENSIVE VIEW OF THE WORKS

[illegible] It is interesting to note that the [illegible] five hundred acres [illegible] the docks and owned by the Midland Railway Company will, in the [illegible] be turned to good account. Even [illegible] the fatigue of a sea voyage, and [illegible] consequent deterioration when they [illegible] the market. This will be avoided in the case of cattle shipped to Heysham, by turning them out to grass temporarily on the company's [illegible] acres. Thanks to the enterprise of the Midland Company Heysham bids fair to become a place of considerable importance, and one cannot help thinking that a good deal of the surrounding pasture land will very soon be turned into streets.

Already the district has undergone a remarkable metamorphosis. A low range of cliffs has entirely disappeared. A large slice has been reclaimed from the sea. A huge stretch of made-up ground has been enclosed, and where the sea once held undisputed sway we have an artificial promontory, the extremity forming the entrance to the new harbour.

As will be seen from the accompanying plan the engineers made provision for the future, as well as for the immediate needs of the company, only a comparatively small part of the

EXCAVATION OF HARBOUR BOTTOM, FEBRUARY, 1901.

—SHOWING FINISHING TOUCHES TO SOUTH ROUNDHEAD, AUGUST 1903.
Water was let into the basin on September 2nd following.

promontory being utilised for the present scheme, *i.e.*, that appropriated for the tidal basin, passenger stations, goods depôt, sidings, power house, workshops, etc. The vast low-lying area, shown on the left of the plan, is held in reserve for future wet docks, graving docks, timber ponds, etc.

GENERAL OUTLINE OF THE SCHEME.

The breakwaters at their junction with the coast at Red Nab on the south, and Near Naze on the north, are about a mile and a half apart, while a distance of 2½ miles separates the two extreme shore ends of the embankments. They gradually converge until the Roundheads at

THE NORTH WHARF IN FEBRUARY, 1901, WITH INCLINED WAY IN FOREGROUND USED FOR TAKING OUT EXCAVATED MATERIAL.

MODEL SHOWING LANDING STAGE CONSTRUCTION.

the mouth of the harbour are only 300 ft. apart, and enclose about 140 acres. The whole estate, including the grazing land above mentioned, comprises about 500 acres. The tidal basin forms a rough parallelogram 2,400 ft. in length by 700 ft. broad. The south quay is immediately adjacent to the railway passenger station, goods sheds and cattle lairs.

The rise and fall of the tide here is considerable, varying between 24 ft. and 27 ft. The harbour has 17 ft. at low water and it is intended to provide for sailings at any state of the tide: a substantial three-decked landing-stage has been carried from one end to the other. Along this and the north quay there is sufficient accommodation for a large fleet, while just inside the harbour, near the end of the northern breakwater, a fish stage has been constructed which is, doubtless, destined to bring about very important developments in the Morecambe Bay fisheries.

Adjoining the quay on both sides of the harbour, a network of sidings has been constructed, and, at the time of our visit, no less than eight miles had been laid down. The entrance to the proposed wet dock has been finished off with a strong dam of brickwork, so that it will be possible to conduct future operations in the dry. Incidentally, it may be noted that when this wet dock is taken in hand it will involve far less difficulty than the adjoining basin.

On the north breakwater is an Anemometer Tower, in which are recorded the direction and pressure of the wind, temperature and barometer readings. The data already accumulated in the office of the resident engineer is being carefully tabulated and has already proved of considerable use. Not far from this tower a tall leading light will be built, which will be sighted by mariners, in conjunction with a low lighthouse and signalling station to be constructed at the extremity of the south breakwater. The lighthouse work is being carried out by Messrs. Chance Bros. and Co., who lately undertook the Beachy Head and Lizard Lights. The latest addition to the tidal basin is a gridiron for the repair of vessels. The site of this, as will be seen on reference to the plan, is at the end of the basin.

LANDING STAGE IN COURSE OF ERECTION.

ONE OF THE SHOES FOR ROUNDHEAD MONOLITHS.

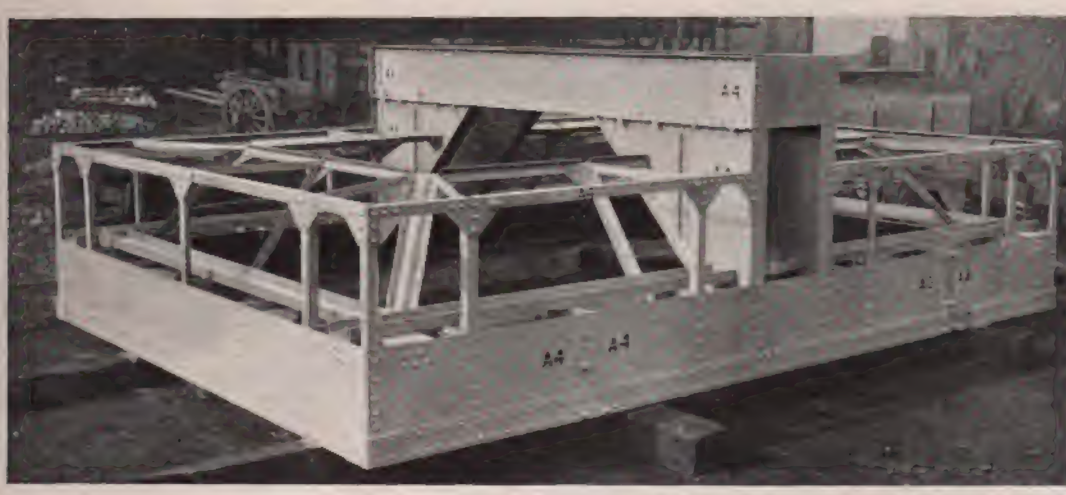
PROGRESS OF THE CONTRACT.

The work commenced in 1897 with the formation of a thin bank corresponding with the present contour of the breakwaters. This was composed of rubble from the cliffs, the outer part being covered with rough blocks of sandstone. The banks were closed in June, 1899, a solid dam being thrown across the space now occupied by the entrance to the harbour.

A sluice built in the centre was found to be of great service, not only in the early stage of the works, but also when the time arrived for water to be let into the dock. It was opened daily at low tide, thus allowing much of the water inside to be cleared by gravitation, thereby reducing considerably the work of the pumps.

The excavation of the harbour was carried on simultaneously with the construction of the quay walls. It involved the removal of three and a-half million cubic yards of earth and sand, and proceeded at the rate of something like seventy thousand cubic yards per month.

The material excavated by the steam navvies was drawn to the top of the banks up an incline by a wire rope, as shown in the accompanying illustration. The lion's share of the



A RECTANGULAR SHOE.

A TOUR ROUND THE HARBOUR, MARCH 8TH, 1904—PANORAMIC VIEW
Roundhead, fish-stage, and north wharf.

work, however, was done by a German steam navvy made by the Lübecker Maschinenbau Gesellschaft and built on the principle of a bucket chain dredger, but with the travel of the buckets reversed. The arrangement will readily be comprehended from the illustration, on page 293. This appliance loaded up the ballast wagons at the rate of six hundred in a ten hours' working day.

In November, 1902, one thousand navvies were engaged on the work, which also gave employment to a varied collection of locomotives, steam excavators and cranes. The works also involved a complete workshop organisation and concrete-making plant, but the latter, at the time of our visit, had disappeared, its work having been accomplished. At one time some seventy boilers were employed for various purposes and fourteen miles of temporary track were in use.

Continuous progress was made with the quay building and excavation until, in September, 1903, it was possible to admit the sea, the harbour being to all intents and purposes, completed. In this operation the sluice in the dam played an important part, as it assisted the engineers in training the water in such a way that a great deal of sand was prevented from entering the harbour. The temporary dam is being removed by hand to low-water level, while last July three English and one Dutch sand pump dredger started clearing the channel between the dock entrance and Heysham Lake, and bucket dredgers with the necessary hoppers are daily expected to complete the removal of the remainder of the dam. Only a small part of the dam now remains visible at low water. On February 16th last, enough had been removed to admit of the sand pump steamers coming inside the harbour at high water.

THE BREAKWATERS.

The breakwaters are strongly faced with blocks of sandstone from Messrs. Whittaker's quarries at Horsforth and from Barrow. The southern arm is somewhat longer than the other in order to afford vessels entering the harbour protection from the heavy south-western gales which are sometimes experienced in the bay. As an instance of the terrible force of these gales one might point to the West End Pier at Morecambe, a large portion of which has been entirely carried away by the sea, leaving a yawning gap in the centre.*

It will be noticed from the plan that the breakwaters gradually taper off in the direction of the Roundheads at the entrance of the harbour. The comparatively narrow ends have also to bear an additional pressure from the sea, and in completing the northern arm it was found desirable to use sheet piling and to stiffen the inner slope with rock rubble, while

* This was done by the great storm in February, 1903, when a train was blown over on the Leven's Viaduct, 11 miles north of Heysham, on the Furness Railway.

—FROM THE SOUTH ROUNDHEAD, LOOKING SHOREWARDS.

In the middle distance is the dam which closes entrance to proposed dock. To the left is the south quay, with adjacent goods sheds and passenger station.

A NEARER VIEW OF THE DAM AND BUILDINGS.

the interior while the sinking of the shoe consequent upon the weight of the superimposed brickwork was aided by its cutting edge. In this way the piers gradually sank until a solid foundation was reached, and, of course, special precautions were taken to ensure that they sank evenly. Steel shoes, built of light plates, were chosen in preference to cast-iron in consequence of the tremendous pressure which these structures have to bear.

Our illustrations show both the square shoes and those of circular form which were used for the Roundheads. The latter were at the time probably the largest structures of the kind extant. Two of them are 55 ft. in diameter, weigh 6,000 tons each, and are each built up of something like one million bricks. They extend 72 ft. below sand level. On reference to the plan it will be noted that the outer ends of the breakwaters are further protected by widening the embankments.

THE TIDAL BASIN.

The tidal basin offers a clear water space of 36 acres. The total length of quay is about 3,500 ft., apart from the space appropriated for trawlers. A minimum depth of 17 ft. has been insured at ordinary spring tides, while at times, owing to the tidal range mentioned above, the water may be within 6 ft. or 7 ft. of the top of the quays. The quay walls are built of mass concrete topped with Shap granite coping. The south quay measures a third of a mile from end to end, the north wall, also of concrete, being 900 ft. in length. The walls are 53 ft. in height, the foundations going down to the solid rock, while at the outer extremities they have been specially strengthened as indicated above. The timbers used as fenders at the north quay, and also for the construction of the landing stage on the south side, are of Australian karri and are about 40 ft. in length. The landing stages present a somewhat extraordinary perspective as may be judged from the accompanying

A TOUR ROUND THE HARBOUR (*continued*).
This view shows a portion of the landing stage at the South Quay.

VIEW FROM THE SHORE END OF THE HARBOUR, SHOWING NORTH QUAY.

illustration. They are connected with the quay above by steps and subways, the walls of the latter being faced with glazed brick.

On leaving the steamers passengers will enter an electric lift which will carry them to a bridge over the line direct to the passenger station, which will be reached by a second lift, so that the interval between steamer and train will be reduced to a minimum.

Cattle will be driven up sloping subways direct to their pens. There is ample space for further siding accommodation should this be required.

ELECTRICAL PLANT, ETC.

Electrical power is to be used throughout the docks wherever possible for lighting, cranes, lifts, etc. The accompanying illustration shows

END OF THE RAILWAY SIDINGS ABUTTING ON THE NORTH QUAY.
Beyond is the mouth of the harbour, with fish stage.

POWER HOUSE AND MOND GAS PLANT.

and gas towers, gas holder, mechanical washer, and scrubbers, blower and circulating pumps, two vertical boilers, coal shoot, bucket elevator, screw conveyor, over-head hopper, coal storage bunkers and automatic fuel weighers.

Other machinery includes two 3-ton capstans and ten of 1-ton capacity, pumps capable of delivering twelve thousand gallons of water per hour to reservoir, two sets of fire pumps, each set consisting of two pairs of pumps driven by motor and each pump delivering 350 gallons per minute or each set delivering 700 gallons per minute and of throwing to a height of 150 ft. through a $1\frac{1}{2}$ in. jet or through four $\frac{3}{4}$ in. jets to a height of 100 ft.

the Power House and Mond Gas installation. The plant includes three gas engines of vertical type, each 250 i.h.p., using Mond gas. Each engine will be direct-coupled to a generator. Each generator will supply continuous current and give an output of 150 kilowatts, normal voltage=460 volts. The storage battery will consist of two sets each of 115 cells. Each cell will have a minimum capacity of 180 amperes for six hours, with a final voltage of 1·85 volts per cell. The battery will be capable of discharging, if required, 300 amperes for three hours. The electrical plant will also include a battery booster of automatic reversible type, arranged to be suitably affected in its action both by the variations in E.M.F. of the cells, according to their state of charge and by the demand for power from the bus bars. The remainder of the plant consists of a power-feeder booster, balancer and lighting booster, two pumps and motors for circulating cooling water round engine cylinders, two air compressors and motors for air necessary to start engines, and a 10-ton overhead crane in engine house.

The whole of the electrical plant and machinery was designed by the Company's Chief Locomotive Engineer, Mr. R. M. Deeley, and was carried out by the British Westinghouse Electric and Manufacturing Company. The Mond gas plant consists of two 6 ft. producers, superheaters, air

THE GAS PLANT IN COURSE OF ERECTION.

RAILWAY WORKS.

At the present time passengers *en route* for Morecambe leave the fast Northern expresses at Hellifield, continuing the journey by a local train. The logical outcome of the dock scheme will be a through service of expresses from Leeds. There is also a loop line from Heysham to Morecambe which will prove useful to tourists breaking their journey at this point, and very shortly there will be a motor service between these places.

The directors have decided to use the harbour station for local purposes, and a road has accordingly been put in from Money Close Lane, past power house, to the passenger station, as shown on map. Every effort is being made to complete the station as soon as possible. The illustration on page 300 shows its appearance on March 8th. The commodious goods sheds have already been completed, while the sidings immediately adjacent to the north quay will give the company every facility for making up their trains of pig iron and merchandise. The large goods shed will have four 30-cwt. electric platform cranes of 15 ft. radius and the same number of 5-ton electric wharf cranes of 34 ft. radius. Four cranes comprising two of each of the kind mentioned will be available for the small shed, while at the west end of the goods shed at the quay side will be fixed a 2-ton electric wharf crane of 33 ft. radius. All these cranes were supplied by Messrs. Stothert and Pitt, of Bath, sub-contractors to the British Westinghouse Company.

IMPLEMENTS AND MACHINERY.

A great deal of interest centres round the workshops, and the implements and machinery used in the execution of the contract, but these we are compelled to dismiss briefly. A large quantity of the plant, including the concrete mixers, has already been cleared away. It may be mentioned that the locomotives used were made by Messrs. Manning Wardle and Co., Messrs. Hudswell Clarke and Co., Ltd., and the Hunslet Engine Company. Messrs. Ruston and Proctor, and Wilsons, Whittaker, and John H. Wilson and Co. were to a large extent responsible for excavators, derricks and cranes. Other prominent features of the plant included pumping machinery by Messrs. Tangyes.

ENGINEERS AND STAFF.

The engineers of the Heysham Harbour scheme are Mr. J. Allen McDonald, M.Inst.C.E. (chief engineer to the Midland Railway), and Mr. G. N. Aberneathy, M.Inst.C.E.. Mr. Baldwin Bent, M.A., M.Inst.C.E., is the resident engineer. The contractors are Messrs. John Price and C. J. Wills, their representative being Mr. Robert Hollowday. To accommodate the work-people an entirely new settlement, known as Klondyke, has been created.

For many of the illustrations we are indebted to Mr. Baldwin Bent: others were kindly supplied by the contractors. Messrs. Handyside and Co. furnished the illustrations of the steel shoes, and the remainder of the views showing a tour of the harbour were taken by the writer.

THE SOUTH QUAY IN SEPTEMBER, 1903.

ELECTRIC TRAINS PASSING AT CROSSENS.

THE ELECTRIFICATION OF THE LIVERPOOL AND SOUTHPORT LINE.

Being some Account of an Inaugural Trip in which the Editor recently participated and a Description of the Plant.

A SMALL party of specially invited journalists representing the technical press of Great Britain attended on Saturday, March 12th, the first trip of an electrically driven passenger train on the Southport section of the Lancashire and Yorkshire Railway.

The honour of possessing the first electrified main lines in this country is shared by the Lancashire and Yorkshire and the North-Eastern Railways. Both these lines have now been prepared for electric traction, but prior to the 12th ult., only experimental trains have been run. This journey between Liverpool and Southport may therefore be said to mark a new era in the history of main line railway travel.

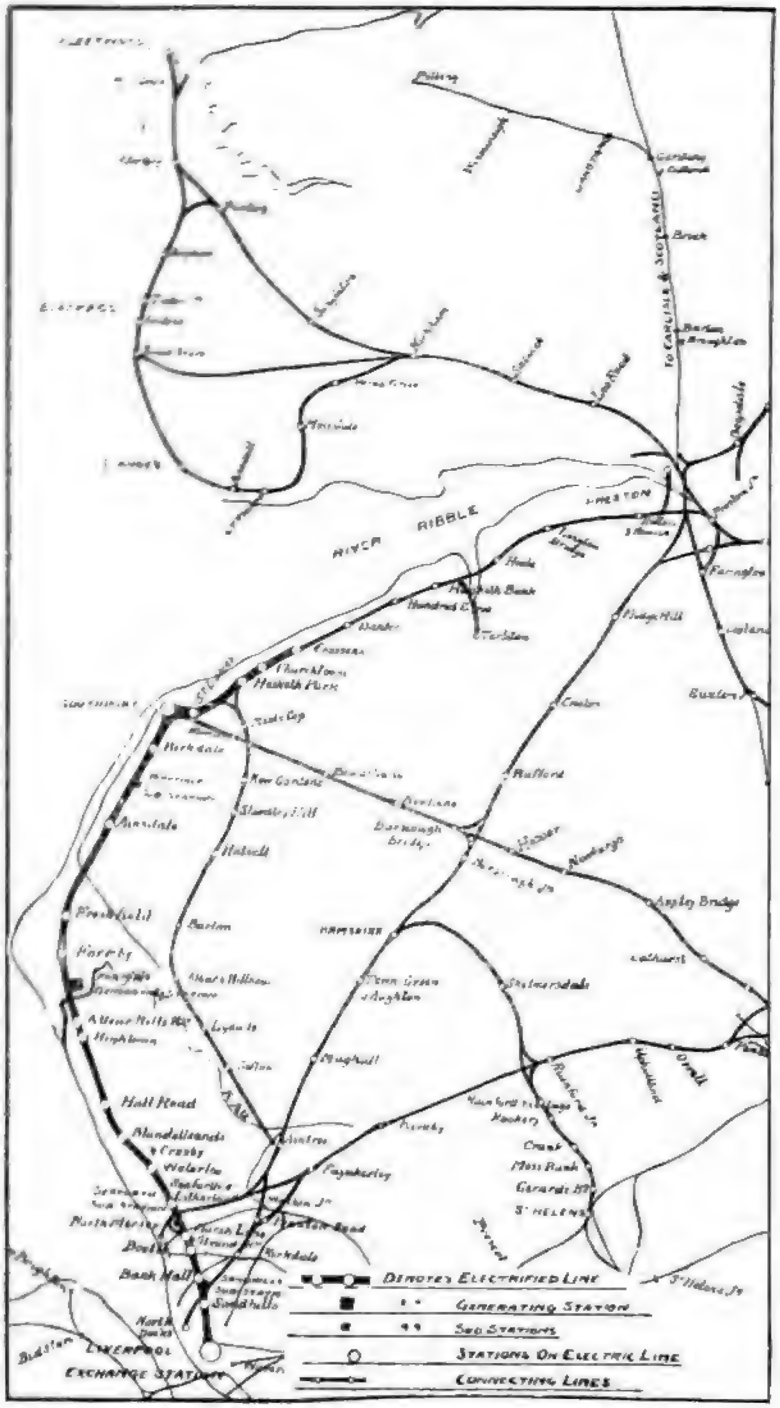
At the sound of a horn the train started without a jar. In a moment or two it had attained a speed of thirty miles, and presently was travelling at sixty miles an hour, the vibration being almost imperceptible. The distance from Liverpool to Southport is nearly eighteen and a half miles, and this was accomplished in twenty-four minutes, in spite of the fact that a signal stop of a couple of minutes had to be made on the way.

The scheme generally was originated by Mr. J. A. F. Aspinall, the general manager of the company, who long ago realised the possibilities of great traffic development in the residential districts which lie between Liverpool and Southport, and on the north side of the latter town. The new service, with its greater facilities, will no doubt lead many Liverpool business men to take up their residence on the north side of the city, and particularly in the charming suburbs on the further side of Southport.

The total length of track equipped is practically equivalent to 47 miles of single line. The gradients on the road are slight, and there are but few curves, the steepest gradient being a short length of 1 in 85 near Waterloo, and the sharpest curve one of 7 chains at Southport; with these exceptions, the line is level and straight. There are fourteen intermediate stations, which lie at an average distance of about one mile apart on the southernmost portion of the route, but are more widely separated on the northern portion. The traffic is almost wholly passenger, business people going to and returning from Liverpool in the morning and evening, with a considerable shopping and miscellaneous traffic during the day.

Under steam conditions, there are about thirty-six trains per day in each direction

between Liverpool and Southport: a similar number running in each direction between Liverpool and Hall Road, a station some seven miles from Liverpool. The majority of these trains stop at every station, a few expresses being run in the morning and evening for the accommodation of the business men. The running times are at present as follow: Express trains 25 minutes, stopping trains 54 minutes, Hall Road stopping trains 25 minutes. The total train mileage per diem is about 1,000.



MAP OF THE ELECTRIFIED AND CONNECTING LINES.

With electrified conditions the train mileage will be increased to 3,200. The number of trains in each direction between Liverpool and Southport will be increased from 36 to 65, and between Liverpool and Hall Road from 38 to 54. Moreover, the running time from Liverpool to Southport will be decreased from 54 minutes at present to 37 minutes, and from Liverpool to Hall Road from 25 minutes to 17 minutes: the schedule time of the fast trains will remain unaltered, but there will be an express in each direction hourly, instead of only rarely. In addition to this, the express trains will run on to Crossens, giving that suburb a service of 17 trains each way during the day. These arrangements, however, do not represent the ultimate capacity of the line, and if the traffic in the course of a year or two were to demand it, there would be no difficulty in running an even more frequent service. It is intended to shorten the stops at the intermediate stations, and as this will make fresh arrangements necessary to deal with heavy luggage and parcels, a special baggage car has been built to deal only with this service. This car will make numerous trips between Liverpool and Southport, and will immensely increase the

ease and rapidity with which parcels can be delivered in the residential districts between Liverpool and Southport.

GENERAL OUTLINE OF SYSTEM.

The portion of the line which has been electrified is shown on the map, and it is obvious that the distance, quite apart from conditions of service, demanded a system of high tension transmission. The electrical energy is generated as three-phase alternating current of 7,500 volts pressure, and transmitted direct to sub-stations, where the voltage is stepped down by statics and transformed by rotary converters into direct current of 650 volts pressure, the maximum voltage at the train being 600.

The power house is situated approximately about the centre of the line, near Formby, directly on the River Alt, being thus favourably situated as regards economical distribution and a plentiful supply of water. The power house is utilised at the same time as a sub-station, from whence part of the electric energy is distributed direct to the adjacent track. In addition to the rotary converters at the main power house, the scheme embraces three sub-stations, the first being at Sandhills, the second at Seaforth, and the third at Birkdale. The distances of these sub-stations from Liverpool are as follows :—

Sandhills station, distance from Liverpool, 2 miles.

Seaforth sub-station, distance from Liverpool, 3¾ miles.

Formby Power House sub-station, distance from Liverpool, 10¾ miles.

Birkdale sub-station, distance from Liverpool, 16⅞ miles.

Near Liverpool it has been necessary to arrange the sub-stations closer together than on other parts of the line, in order to cope with the considerably heavier traffic of the local trains running from Liverpool to Hall Road and *vice versâ*. The extreme ends of the line —from Sandhills sub-station towards Liverpool, and from Birkdale sub-station towards Southport and Crossens—are each fed by one sub-station, whilst for the intermediate sections of the line two sub-stations participate in supplying energy to the trains, the demand of energy supplied from each sub-station depending on the position of the train between the sub-stations. The sub-stations are situated near the track, thus avoiding any low tension cabling, except a short connecting length.

The system is arranged so that any sub-station can be disconnected if required.

POWER STATION.

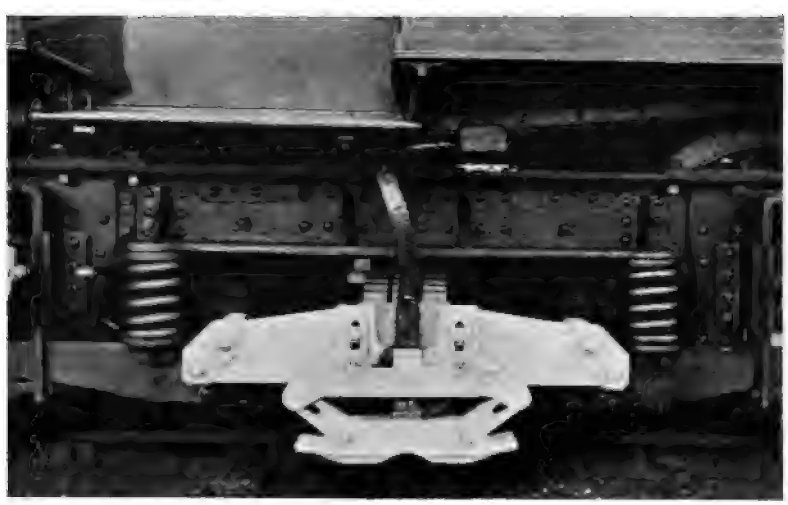
The equipment of the power house has been laid down on simple lines, and there are none of the unnecessary luxuries and refinements which characterise many of the modern power and lighting plants.

It has been erected by Messrs. Thomas Croft and Sons, of Preston, to designs prepared by Messrs. Dick, Kerr and Co., and upon elaborate foundations which were constructed by Messrs. Monk and Newell, of Bootle, under the immediate supervision of the engineers of the Lancashire and Yorkshire Railway Company. It consists of two divisions, the engine room being 280 ft. long by 65 ft. wide, and the boiler house, which is 50 ft. wide, with a similar length of 250 ft. The building consists of a steel roof in two bays, carried upon steel columns, all of which are independent of the brickwork, and which have been made by Messrs. Head, Wrightson and Co., of Thornaby-on-Tees. The engine room is provided with admirable lifting and travelling machinery in the way of overhead cranes, which are capable of dealing with pieces of machinery up to 20 tons, and which are operated electrically. They have been built by Messrs. Jessop and Appleby, of Leicester.

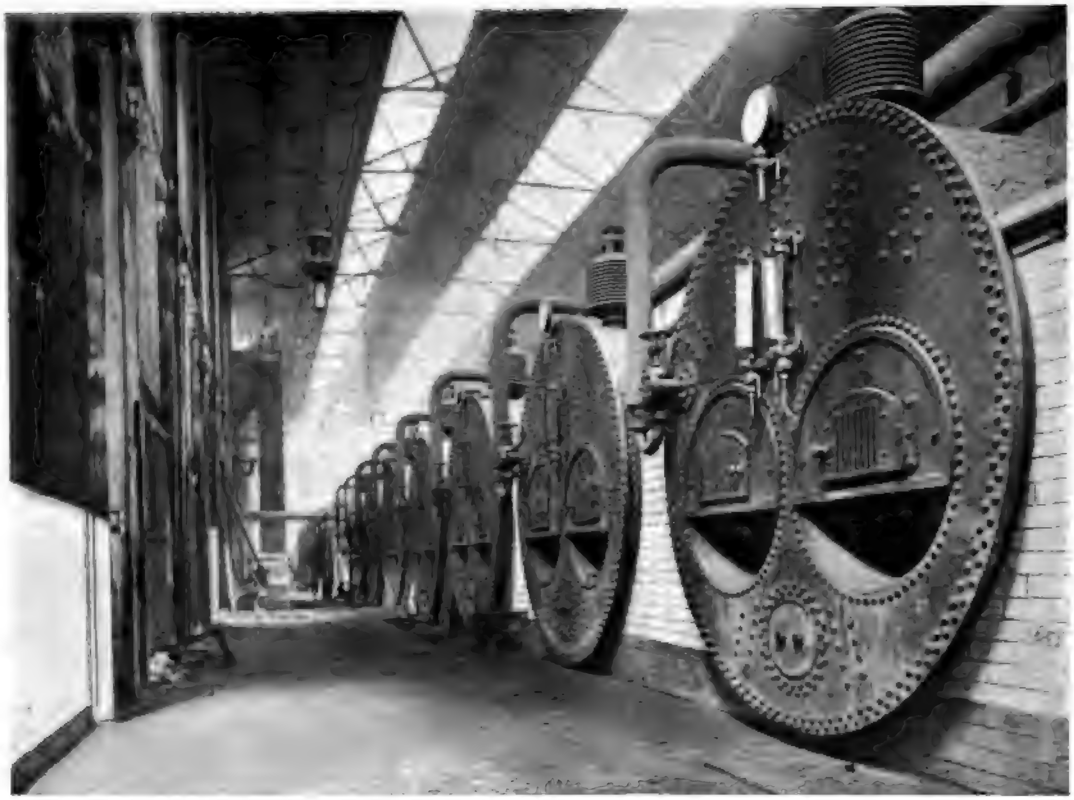
For obvious reasons the size of the units is as large as possible compatible with the running of a reduced service with a good load factor.

There are installed four 1,500 kilowatt units, of which three will, under normal conditions, meet the demands. In addition, there is a fifth unit of 750 kilowatts, which will form a useful link between the larger units, and thus permit considerable flexibility in obtaining a good load factor with high efficiency.

The four main engines are of the horizontal cross compound type, the fifth engine being a vertical cross compound. The horizontal engines have cylinders



COLLECTOR SHOE ATTACHED TO UNDER-FRAME.



VIEW IN BOILER HOUSE.

32 in. and 64 in. diameter, 4 ft. 6 in. stroke, and run at 75 revolutions per minute. The normal load of each engine is 2,310 h.p., with a steam pressure of 160 lb. per square inch, but they are designed to give an overload of twenty per cent. The main engines, as well as the boilers, were supplied by Messrs. Yates and Thom, as sub-contractors to Messrs. Dick, Kerr and Co., Ltd.

Specially powerful and sensitive governors have been fitted to the engine, in connection with which are several devices, designed for securing good parallel running, and for dealing with greatly varying loads. Each governor is also fitted with a special safety stop arrangement, which will completely stop the engine in the event of its reaching a speed ten per cent. above the ordinary working speed, and will also shut down the plant in the event of any failure of the governing gear, yet this is accomplished without interfering with the engine taking excessive overloads, even beyond the full range of the cut off gear.

Each fly-wheel is 22 ft. diameter, and is directly attached by strong bolts to the rotor, which is otherwise independent of the fly-wheel. The engines are solidly constructed, and of massive proportion, the weight of each bed frame being 14½ tons. Each crank shaft main bearing weighs about 11 tons, and the crank shaft 17 tons, the cranks weighing 5 tons each.

Each engine is fitted with a condensing apparatus, consisting of two Edwards' air pumps worked from the low-pressure tail rod by means of links and levers. The condenser, which is of the jet type, being suitably placed relatively to the cylinder and to the air pumps and having in connection with it a sluice valve, and an automatic exhaust valve, so that the condensing apparatus can be thrown out of action, and the engines run non-condensing when required.

The alternators are 3-phase, 25 cycles, the larger running at 75 revolutions and the smaller at 94 revolutions per minute, with a pressure of 7,500 volts. These machines, along with the remaining electrical plant, were made at the Preston Works of Dick, Kerr and Co.

The weight of the magnet wheel complete is about 48,500 lb. of which the poles account for 12,800 lb. and the spools 6,350 lb. The complete stator weighs 75,800 lb. Each coil is fully insulated, dried and tested to 15,000 volts before being inserted in the slots.

The constructional features of the 750 kilowatt alternator are almost identical with those of the 1,500 kilowatt sets. There are three direct-current exciter sets, each consisting of a standard Dick-Kerr 4 pole 100 kilowatt generator coupled to a Willans and Robinson high-speed engine, running at 380 revolutions per minute, the working voltage being 125. They also operate the station lights and ash conveyer and barring motors. The general design of the machine is on the well-known Dick-Kerr lines.

The main switchboard is erected on a gallery over a fireproof high-tension chamber, and is built up of thirty-three 2-ft. panels of enamelled slate. The whole of the high-tension switch gear, oil switches, instrument transformers and bus bars are erected

in a fire-proof H.T. chamber, the dimensions of which are 79 ft. by 12 ft., and constructed of steel girders and concrete.

The chief feature of the alternating board is that the high-tension current is confined to the pit below the board, this being effected by the long arm oil switches which are used throughout the system.

The rotor field rheostats are of massive construction, and consist of cast-iron grids insulated with hard micanite and assembled in frames forming layers in a vertical stack which open top and bottom for thorough ventilation.

BOILERS.

There are sixteen boilers made by Messrs. Yates and Thom, of the Lancashire type, each boiler is 32 ft. long by 8 ft. 6 in. diameter, with two flues each 3 ft. 5 in. diameter, constructed for a working pressure of 160 lb. per square inch, the shell plates being 13-16 in. thick, flue plates 9-16 in. thick, and the end plates ¾ in. thick; each shell being in five rings of one plate each. The boilers were tested satisfactorily to 260 lb. per square inch. They are equipped with a full set of fittings and mountings made by the same firm, and are hand-fired. They are arranged in two batteries of eight each in one row.

In each of the down-take flues at the back end of the boilers is fitted a superheater of the Galloway type. The feed pumps were supplied by Messrs. Mather and Platt, Ltd.

The fans for the induced draft work are two in number, each capable of furnishing sufficient air for the consumption of 10,000 lb. of coal per hour with a temperature of the flue gases after passing through the economisers about 400 deg. F. and this under a normal speed of 175 revolutions per minute.

The products of combustion after passing through the economisers enter the fans at a temperature of about 400 deg. F. and are discharged through underground brick ducts to the base of the chimney located just outside the building. This chimney has a height of 60 ft. in order to discharge the products of combustion above the surrounding buildings. The whole of the induced draft apparatus was supplied by the Buffalo Forge Company.

The economisers, working in conjunction with the boilers, were made by Messrs. Green and Son, Ltd., and are constructed in groups of 120 tubes. The installation on the whole contains 1,440 tubes, representing 14,400 square feet of heating surface.

SUB-STATION EQUIPMENT.

The sub-station equipment, save as regards amount of plant, is identical, and to describe one in detail will give an adequate idea of the whole of them. The three largest, Seaforth, Sandhills and Formby, have each four rotary converters, whilst Birkdale has three, provision being made in each case for extensions. Each rotary converter is arranged with its corresponding groups of statics alongside; the high-tension oil switches being placed underground.

The rotary converters are in appearance similar in general design, to the standard d. c. machines.

INTERIOR OF POWER HOUSE.

THE JUNCTION AT SANKEY HILLS.

They are 6-pole developing 600 kilowatts at 600-650 volts at 375 revolutions per minute.

The average finished weights are: Armatures 10 380 lb., magnets 21 100, complete machine 40,940 lb.

The transformers are of the air-blast type, and have each a capacity of 200 kilowatts. They are circular, and are built up of copper strip wound on edge and insulated with special wrappings repeatedly impregnated and dried. The secondaries are inside next the core, the primaries above and outside. Ample ducts are left between the coils, core, casing and each other to afford free passage for the blast, which entering below, may be regulated by a baffle above.

The blowers, of which there are two in each sub-station, consist of a standard Dick-Kerr 5-h.p. motor, coupled on a combined base to a Davidson Sirocco fan which is keyed direct on the motor shaft. The capacity of each fan is 8,000 cubic feet of air per minute at a pressure of 2 in.-3 in. of water.

The sub-station switchboards consist of a high-tension and low-tension side, the latter having been supplied by Elliott Bros., the switches and circuit-breakers being of the standard Dick-Kerr pattern.

HIGH-TENSION TRANSMISSION.

The high-tension cables leading from the power house are arranged in each case in triplicate. Under ordinary working conditions all three cables are used, but in case of breakdown of any one of the cables the two remaining ones can do the work without the drop or the current density exceeding the permissible limit.

The whole of the cables were manufactured and laid by Messrs. W. T. Glover and Co., Ltd., as sub-contractors. The extra high-tension cables are of the triple triangular type, diatrine paper insulated lead-covered and armoured, laid on the solid system.

Four different sizes of cable were used:—

37–15, 37–16, 19–15, 19–16.

The length of each being respectively: 13 miles, 6½ miles, 6½ miles and 18 miles—a total of 44 miles.

The insulation consists of Manilla paper impregnated with diatrine by a special process which ensures that the paper is thoroughly impregnated, the surplus compound being removed from the surface of the paper by means of a special apparatus.

The armouring is of galvanised steel wires ·8 to ·1 in. diameter, which acts as a mechanical protection in addition to making a most satisfactory and efficient earthing conductor.

The joints are of the plumbed-lead sleeve type, the lead sleeve being filled up with diatrine compound.

The troughs are made of stout wood, tarred and creosoted, filled with compound, and covered over with tiles. Specially prepared impregnated wood bridges support the cables at 18 in. intervals. The cables are laid for the most part in the six-foot way, and where they pass over bridges or in exposed situations are laid in stout steel troughs.

PERMANENT WAY.

The permanent way is, for the purpose of distributing and returning the electric current, equipped with two additional rails. One of these current rails is brought alongside each track on insulators, whilst the other rail is placed between the running rails, uninsulated on the sleepers, this forming the principal

part of the return circuit. Whilst the joints of both the third and the fourth rail are bonded in the ordinary way in the manner described below, the fourth rail is, also, cross-bonded to the running rails, the ends of each running rail being connected by such a bond to the fourth rail, and, whilst, by this arrangement, the troublesome bonding of the running rails is avoided, as also the complications involved by using an insulated fourth rail for the return, the further advantage is obtained that the running rails participate to a marked degree in conducting the return current, thus increasing the conductivity of the return circuit, with consequent reduction of drop. No collector shoe is provided on the train for the fourth rail, the current being delivered through the wheels to the running rails, and thence, through the cross-bonds, to the fourth rail.

The installation of this rail also makes it a comparatively simple matter to renew the running rails without unduly interfering with the continuity of the return circuit.

The third and fourth rails are both of equal section and consist of mild steel of special high conductivity, the resistance being proved by test to be not greater than seven and a-quarter times that of pure copper. As a matter of fact, the average resistance is somewhat lower.

The rails have been supplied by the North-Eastern Steel Company, of Middlesbrough, are of Vignoles section, weigh 70 lb. per yard, and are in lengths of 60 ft.

The third rail is supported at intervals of about 10 ft. on insulators of reconstructed granite, held in position by two clips, the centre of the rail being exactly 3 ft. 11½ in. from the centre line of the track, and the top of the rail 3 in. above the surface of the track rails, this dimension being that agreed upon by all the main line railway companies, at a meeting held at Clearing House, on March 3rd, 1903, in order to obtain uniformity, in case of extensions of third-rail system. It is of ample section to convey the full amount of current required by the trains, when between two sub-stations, without causing any appreciable loss in voltage. Generally, the third rail is placed in the 6 ft. way between the tracks, but occasionally it is brought outside the track, to suit special conditions. At all level crossings gaps in this rail have been provided of such a length that there can be no risk whatever to the public; where these gaps occur the third rails are bonded with cable underground. Timber guarding has been provided at all the busy places on the line, to prevent the possibility of any person coming into contact with the third rail.

The fourth rail is supported on wooden blocks, and is placed in the middle of the 4 ft. way between the two running rails.

At most stations the third rail is interrupted and the ends are connected by cables to section switches. This apparatus consists of four knife-switches, one for each end of the up and down line, which, in the ordinary way of working, are connected in parallel. By cutting out one of these switches in two adjacent boxes, any part of the up or down line may be made currentless.

The fish-plates at the expansion joints are of special design, and properly slotted to provide for any change of length which may take place in the 300 ft. section. The terminals of all the bonds are of solid copper, and are expanded in the bond holes by means of screw or hydraulic compressors. Each track rail is bonded to the fourth or negative rail by means of flexible cable bonds supplied by the Forest City Electric Company.

THE ROLLING STOCK.

The trains consist in most cases of two first and two third-class cars, the latter being at either end, and equipped with two motor bogies each bogie carrying two 150 h.p. motors. There are, consequently, eight motors per train. The current is conveyed to the motors through a cast-steel slipper, attached to a beam on each side of the motor bogie, which rubs on the third rail.

Both types of cars are 60 ft. long and 10 ft. wide, being the widest carriages in this country, and have 8 ft. wheel base bogies fixed 40 ft. 6 in. centre to centre apart. They are arranged with straight sides, match-boarded below the side lights.

There is a monitor or clerestory roof 6 ft. 2 in. wide, the top being 12 ft. 7⅞ in. from the rail level. The vehicles are painted in the company's standard colours of brown and crimson lake. The motor cars are divided into two main compartments with a luggage and motor compartment; access being obtained through entrance vestibules which are recessed back at either end, the whole arrangement being so designed that the doors shall not project beyond the 10 ft. width when extended. Immediately inside the compartments the seats are placed longitudinally against the side of the car so that ample space is allowed for the inlet and outlet of passengers. The cars are otherwise fitted with cross seats and reversible backs with a passage between, the first class accommodating two on either side and a total of sixty-six passengers per car, the third class seating three on one side, and two on the other, and a total of sixty-nine passengers per car, the total accommodation in a normal train being in this way 270 passengers.

Between all cars vestibule gangways are provided, and it is therefore possible to pass from one end of the train to the other, only those between first class being for the use of passengers.

All cars are electrically lighted and heated, the necessary switches being placed in the vestibule entrance of each coach, and so arranged as only to be accessible by means of a special key carried by the guard. There is a through bell communication which enables the guard, by means of a special key, to give the motorman the signal to start from any vestibule entrance on the train.

The total weight without passengers of each trailer car is 26 tons, and of each motor car 44 tons, making the total weight of each four-car train 140 tons, and a length over all of 248 ft. 6 in.

The bogies for the trailer cars are the company's standard carriage bogie, the frame being composed of angle-steel section, and channel-steel bolsters. Special springs have been introduced to ensure easy riding.

The current is collected on each side of the motor bogies by cast-steel slippers weighing about 90 lb. each. On straight runs of third rail there are thus four shoes collecting at one time. From these slippers which are suspended by forged slotted links from a wooden beam carried on extensions on the bogie, a highly flexible lead of special construction is carried to a fixed terminal from which the main cables pass to the controller.

The vacuum brake is used on the trains, thus making them adaptable for service with the company's other rolling stock and locomotives at any time.

The motor compartments have, with the exception of the roof, which is covered with sheet-steel plates, been lined with uralite, the floor also being fire-proof.

In addition to the cable troughs, in which the cables

are placed for conveying current to the motors, and equipment, being lined with uralite, the whole of the floor over the motors is covered with the same material and thin steel plates. All the trains carry fire appliances, and ample steps have been taken to ensure safety in this respect.

As has been already stated there are eight motors on a complete train, which drive on to the axles through single reduction gear. They are of the Dick-Kerr 4-A railway type, rated to develop 150 b.h.p. at an armature speed of 470 revolutions. The weight of the complete motor is 6,050 lb., the armature 1,920 lb., and the gear wheels and housing 500 lb. Its main features are similar to those of the standard traction type.

One of the most interesting features of the equipment is the method of control, which may be termed the direct multiple control system, in contra-distinction to the multiple unit, the main difference in the systems being that in the case of the former it is possible to control the whole equipment of the train by means of two main cables. Previously, the great difficulty in the way of such a simple arrangement lay in the construction of the controller, it being practically impossible to carry the whole of the current through one controller.

In the Dick-Kerr system this is rendered possible by the use on the controller of the metallic shield blow-out, which is part of the standard design of their tramway and railway controllers. They contain two power cylinders, each controlling one-half of the train, that is, one motor car is actuated from one cylinder and the rear motor car controlled from the other. Without, therefore, interfering in any degree with the completeness of the train, it would be possible to divide one of the present trains into two distinct units.

Photo. by N. S. Kay, Bolton.]

MR. JOHN A. F. ASPINALL, M.I.MECH.E., M.INST.C.E.

The train is entirely operated by the motorman from his cab at the front, in which there is a Dick-Kerr D.M. four-controller, capable, in conjunction with eight reversers, which are bolted up adjacent to their various motors under the floor, of operating the eight motors on the pair of motor cars.

The reversal of direction of the motors is effected by means of a special apparatus operated by the controller reversing barrel.

The complete scheme, with the exception of the rolling stock, which was made at the Horwich and Newton Heath Works of the railway company, was entrusted to Messrs. Dick, Kerr and Co., Ltd., of London, Preston and Kilmarnock, who may take credit for being the first firm in England to carry out and complete a main line electrification. The work of electrifying the line has been completed in a remarkably short time. Twelve months ago the work of construction had not been begun, yet on March 1st, 1904, a scheme embracing 47 miles of permanent way, a transmission plant of 12,000 h.p. and a complete train system has been carried out. Moreover, this has been achieved without interference with the running of the steam service. These results are mainly due to the untiring energy of Mr. Aspinall, seconded by the efforts of the contractor.

ANDREW CARNEGIE, LL.D.,

President of the Iron and Steel Institute.

Mr. Andrew Carnegie's latest claim to distinction is the offer of a donation of £300,000 for the erection of a Union engineering building, which has been accepted by the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Mining Engineers, and the Engineers' Club. There is scarcely any need to remind technical men that he is at the present time filling with conspicuous ability the position of President of the Iron and Steel Institute. Mr. Carnegie was born at Dunfermline, on November 25th, 1837, and went to America as a boy of thirteen. His rise was coincident with the boom in railway building which set in after the American Civil War. Important factors in his career have been an extraordinary foresight and grasp of opportunities, and an infallible judgment of men, as exemplified in his choice of business associates. The Carnegie libraries of this country have exerted an influence on the masses the extent of which will perhaps never be fully realised.

The War between Russia and Japan:

A MONTHLY SURVEY.

BY

N. I. D.

A SIMILE borrowed from the theatre has been used by nearly every commentator upon the present war, in referring to the sudden cessation of trustworthy news of the movements of both parties, since the second week of the war. We have had, it is true, driblets, a corner of the curtain has been raised every now and again, but of the general campaign, there have been no tidings. It is as if we had seen the naval curtain raiser, and were waiting for the first act of the great military drama.

It is not to be denied, of course, that Japan is quite right to keep her movements shrouded in uncertainty. News telegraphed to England can be re-telegraphed to St. Petersburg, and thence made known to Admiral Alexeiff, General Stoessel, and Vice-Admiral Stark, or their successors. But, at the same time from certain indications which have occasionally appeared in the Press, it is quite possible to deduce a probable scheme of action.

Last month there was only an opportunity of stating the facts about the naval encounters which crowded thick and fast upon each other's heels, and to give in detail a comparative statement of the naval strength of the opposed Powers. This month some particulars may be added, speculative in the main, but founded upon fairly reliable reports, as to the relative military strength of the belligerents.

The Japanese army can rely in an emergency upon a regular army of 7,500 officers and 190,000 men. These are divided into 52 three-battalion regiments of infantry, 55 squadrons of cavalry, 19 regiments of field artillery, with six guns to each battery, 20 battalions of fortress artillery, 14 battalions of engineers, including one of railway specialists, and thirteen transport battalions. To these figures are to be added 35,000 officers and men in the reserve, and 200,000 men of all arms in the territorial army, making a total in round numbers of 430,000 officers and men, with 1,200 guns and 90,000 horses.

How many of these are already landed in Korea? We may assume the fighting strength of a Japanese division at 14,000, to be added to which is the reserve brigade of the division, of about another 6,000. It has been stated that three divisions have been landed at various points in Korea, Masampo, Fusan, Chemulpo, and Chenampo. In Korea, therefore, Japan has probably an army of from fifty to sixty thousand combatants.

What force has Russia to oppose this? It is evident that the figures which were supposed to be accurate before war broke out were very largely exaggerated. We were led to believe for instance, that the garrison at Port Arthur was 30,000 strong. It is now known to be about 15,000. Allowing, then, for such exaggeration, and allowing also for garrisons, railway guards, and convoys, it is doubtful if the Russian army on the Yalu numbers more than 25,000. Two months ago it might have been urged that the Trans-Siberian railway would soon remedy this, that Russia would simply pour troops into Manchuria and Korea. But, as is often the case, two months have served to demonstrate the utter futility of peace

experiments as a criterion of what can be done under stress of war conditions.

The Trans-Siberian Railway is the one link between the Russian army in the Far East and its source of supplies, of men, munitions, and food. The sea is closed to the Russians, the recalling of Admiral Virenius's squadron from Djibutil proves it. Everything that the force under Admiral Alexeiff needs must pass over a single line of railway, which could be thrown hopelessly out of gear by a daring and successful raid by any of the many turbulent tribes in Mongolia.

The line is over six thousand miles in length from Moscow to Vladivostok. There is only one tunnel in the whole line, but there are no fewer than thirty miles of bridges, the breakdown of one of which would disorganise the whole of the traffic, already known to be in a frightful state of congestion. From Moscow to Irkutsk the line is laid with some care, but thence to Harbin it is little more than a sheep track in places, and luckless travellers have described their experiences in pathetic language. Lake Baikal is, of course, the most difficult obstacle on the whole line. The attempt to run trains across the ice has partially failed, and the passage has mostly to be made on sleighs. The journey takes five hours, and the piercing cold out on the lake has already resulted in many fatal cases of frostbite, besides rendering many of those who survive their injuries useless as fighting units. It is true an attempt is being made to carry the railroad round the shores of the lake, but this must necessarily be a matter of some time.

The line itself has a carrying capacity of about 1,400 men a day, with horses and provisions. But it is significant that in those descriptions of the railway which have appeared since the war began, no mention is made of horses, except in one instance, when a correspondent remarks: "In the whole course of my journey (from Vladivostok to Moscow), I saw no horses being hurried forward, though I understood that there were several thousand expected." It would appear, then, that the much-talked-of superiority of the Russian cavalry is to be minimised by the lack of horses.

To come back, however, to the situation in the theatre of war, it will have become obvious that by their naval victories and the rapid pushing forward of their land forces, the Japanese have thrown the Russians back on to their frontier, which may be defined as a straight line from Port Arthur to Vladivostok, cutting the Yalu River at about An-Tung, where it is believed the main body of their army was at one time gathered. This may be taken as the centre of the Russian position. Japan's scheme of action appears to be, then, to keep both ends of the line busily engaged warding off attacks by sea while she steadily prepares a heavy blow at the centre by land. And to this end her naval supremacy lends her the necessary aid. The original intention was to land her troops at Fusan and Masampo. But the first victory at Port Arthur opened the Yellow Sea to her transports, and she promptly proceeded to put a division ashore at Chemulpo, and to occupy Seoul. Later events have rendered it possible for her to send her transports even further up each coast of the peninsula, and she is now disembarking men at Chenampo on the east and Gen Sen on the west, both divisions concentrating probably at Ping Yang, and meeting there some portion at least of the division landed at Chemulpo, which will, in all probability, be somewhat weakened, first by the fatigues of the march, and secondly, to supply guards for the communications. As soon, however, as Ping Yang is a properly equipped base, these can be withdrawn.

Such appears to be the outline of the Japanese plan of campaign. It was probably the original intention to march the divisions right through Korea to the Yalu, but the unexpectedly rapid disposal of the Russian fleet led to a modification which will eventually save both time, men, and stores. The landings reported on the Liao-Tung Peninsula, and at Possiet Bay, if they have any foundation, seem to be mere diversions, with the same end in view—the constant occupation of the forces at the terminal points of the frontier with their own safety, while the great blow at the heart of Russian military power in the Far East is preparing. That the Japanese authorities realise the immense moral value of an initial success is certain, and that no move will be made until success is, humanly speaking, assured, is no less so.

The naval movements have not been of very great importance since the first article appeared. Those in the Far East have been mainly in the nature of reconnaisances, for the bombardment of Vladivostok could not have been anything more, and the engagement at Port Arthur in the early morning of March 10th, while important enough in its way, was little more than an outpost affair. Admiral Togo, in his report, says that one of the divisions of destroyers posted itself so as to watch the entrance, and the other was employed in laying mines "in various places," obviously with the object of sealing up the port. At about half-past four the watching flotilla came into contact with a division of Russian destroyers, and a severe fight ensued, in which the Japanese lost seven killed and eight wounded. The vessels were not disabled. Two Russian destroyers, in making their escape after the action, fell in with the Japanese division engaged in laying mines. A further engagement took place, lasting about an hour, from which one destroyer escaped—the other, the *Stereguschtchni*, was sunk, the survivors of her crew being taken on board the Japanese destroyer *Sazanami*. In this action the Japanese lost two more killed and three wounded. According to Admiral Alexeiff's report, the Russian losses were only four slightly wounded, but it seems certain that this must be incorrect.

The Japanese squadron subsequently bombarded the port rather heavily, but with what amount of success is not yet certain.

The European Powers have been very careful to impress upon Japan the necessity for strict observance of the neutrality laws, and the prolonged stay of the Russian fleet under Admiral Virenius at Djibutil is the more remarkable. The fleet consisted of the battleship *Osslabia*, the cruisers *Dimtri Donskoi* and *Aurora*, and some twenty torpedo vessels. In passing, it may be noted how little things emphasise the difference between the administrative powers of the belligerents. At one time Russia had this squadron in the Levant, and at about that time the two new Japanese cruisers *Nisshin* and *Kasuga*, manned by scratch crews, with their heavy guns unmounted, and much internal work unfinished, set out from Genoa. They were shadowed through the canal and the Red Sea by the Russian ships, and everyone expected to hear at any moment that they had both been sent to the bottom. And yet to-day they are safely in Yokosuka, fitting out for service, and the Russian fleet is pottering about the Eastern Mediterranean, "a *quantité négligeable*." It is reported that this squadron will in the spring be reinforced from the Baltic. In what condition the vessels under Admiral Virenius will be then passes comprehension. One torpedo boat we know to be *hors de combat* at Port Said; another has been sunk; the *Dimitri Donskoi* has been reported to me in a communication from a friend to be in a pitiable condition, and the flagship is far from being wholly effective. To keep these ships hanging about there another six months is as suicidal a policy as was the leaving of the Port Arthur fleet at anchor in the open roadstead. The two actions are a striking commentary upon that fatal lack of comprehension of what a navy is for which has marked the Russian naval administration for the past three months, and which was admirably illustrated in an article in the *Kronstadski Viestnik*, which declared that the passive attitude of the Russian fleet in the Far East was of immense importance, since its presence covered the right wing and rear of the army, as well as the railway connections with Port Arthur. The article went on to say that by this passive attitude a landing by the Japanese on the east or west of the Liao-Tung Peninsula was rendered impossible, and that if the Russian fleet were despatched in search of the enemy it would amount simply to leaving the coast line at the mercy of the Japanese. If events do not further falsify this peculiar idea of the use of a fleet, naval experts, both in this country and the United States, have strangely misapprehended the situation.

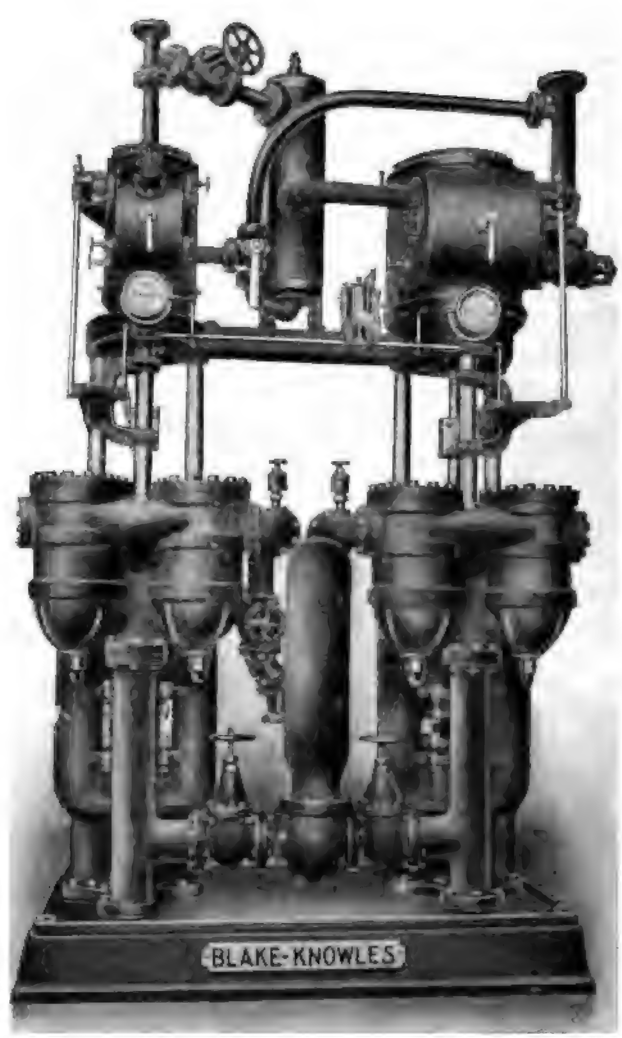
Vertical Simplex Cross-Compound Centre Packed Plunger Pumps for Lots Road Generating Station.

WE illustrate on this and the following page the type of vertical direct-acting boiler feed pumps which have been supplied by Messrs. The Blake and Knowles Steam Pump Works, of Queen Victoria Street, E.C., for the Lots Road Power Station installation. Each set is provided with a 16-in. high-pressure steam cylinder and a 9½-in. pump cylinder of 18-in. stroke; also a 26-in. low-pressure steam cylinder and a 9½-in. pump cylinder of 18-in. stroke.

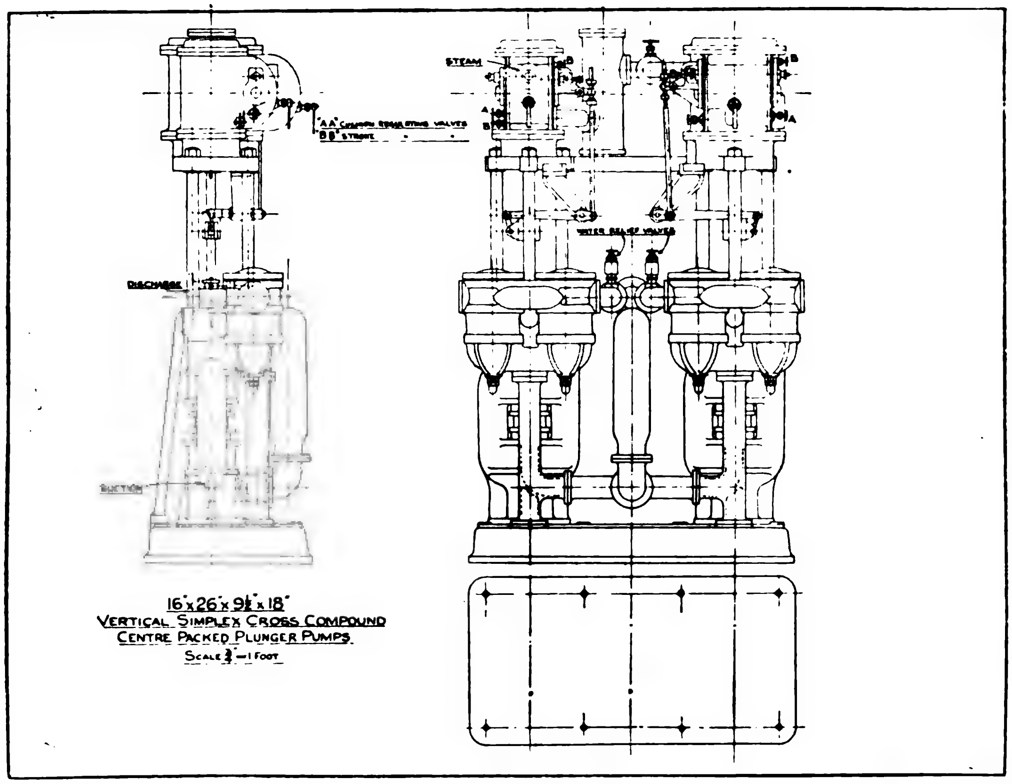
The complete set consists of two vertical simplex pumps connected so that they run as a cross compound machine, but arranged so that each pump can work independent of the other. One pump has a small steam cylinder for high-pressure steam, exhausting into receiver, and from thence into the low-pressure cylinder, thus using the same expansively.

The valve motion has been specially designed for the work, so that high pressure steam can be used, and this at a high degree of superheat. The water ends are also of special design, the pump cylinders being of the plunger pattern, centre packed, and the plungers highly polished, so as to reduce the frictional conditions to a minimum. The material used for the plungers is hard chilled iron. The connections between the two steam cylinders and the suction and delivery arrangement between the two water cylinders enable either side to be operated alone. In fact, practically a duplicate arrangement of pumps can be arranged. These pumps are built for a working pressure of 225 lb. and they have to deliver at the rate of 300 gallons per minute, while running at 18 double strokes, this being equal to a delivery of 18,000 gallons per hour, or sufficient to feed water for a turbine plant of about 10,000 h.p.

Seven sets are comprised in the installation, the first of which was run to the satisfaction of the engineers at the station, before final instructions were given to proceed with the balance of the order. This is the largest order for boiler feed pumps for this service that has ever been placed.



PART OF THE PUMPING PLANT AT LOTS ROAD POWER STATION.



SEVEN SETS OF THESE PUMPS HAVE BEEN INSTALLED AT LOTS ROAD BY MESSRS. BLAKE AND KNOWLES.

THE ELECTRIFICATION OF THE METROPOLITAN—A SECTION EQUIPPED WITH CONDUCTOR RAILS.

Messrs. Graham, Morton and Company's New Works.

ON March 11th about one hundred and fifty engineers and representatives of the press visited Leeds for the first informal inspection of Messrs. Graham, Morton and Co.'s new engineering works at Hunslet. Before the business of the day commenced an excellent luncheon was served, and following a tour over the new premises an inspection was made of the large installation of inclined retorts at the New Wortley Gas Works, this being the nearest available piece of work among the many contracts which the company has on hand at home and abroad. Messrs. Graham, Morton and Co. are to be congratulated on the removal of their establishment to a position three miles from the centre of Leeds, for not only will the company be able to carry out operations commensurate with its opportunities, but it will possess one of the best designed works in the United Kingdom or even America. We are reminded that though Messrs. Graham, Morton and Co., Ltd., are a young firm they have already executed some large contracts. In 1901 the firm undertook an installation of Inclined Retorts at Edinburgh, completing it within the short period of nine months, its value being £120,000.

That the new undertaking has been carried through with commendable celerity will be understood when it is stated that on May 16th, 1903, the site on which the works and offices now stand was an unoccupied field. Five and a-half months later machinery and men were at work, and the office staff was installed in its quarters. An important point about the new scheme is that provision has been made for a siding connecting the works with the Hunslet branch of the Great Northern Railway.

The new premises comprise two blocks of buildings —the offices and the works. The latter are in the form of three bays, and are of steel and glass, on a foundation of brick and concrete, the main floor being 400 ft. long and 140 ft. wide. The roof and sides are of glass, supported by steel girders.

In the section devoted to constructional ironwork manufacture a number of bridges were to be seen in the making. Fifty-seven are for the North-West Provinces of India, to the order of Bengal; seven are to the order of the Great Western Railway Company; others are for the Halifax Corporation, and the remainder are in fulfilment of Admiralty and War Office contracts. In the centre of the floor sections of roofing for tramway stations were being completed; a second group of men being engaged on elevating and conveying work for Melbourne and Sydney, Australia.

The tool shop, where all the tools required in the works are manufactured, attracted a good deal of attention, and a good deal of interest naturally centred in the power house, which has two sets of Bellis and Morcom's high-speed engines, coupled direct to 150 kilowatts generators (equal 200 h.p.) each running at 450 revolutions per minute, and generating 220 volts.

The motors were all manufactured by the Phœnix Dynamo Manufacturing Company, Ltd., of Thornbury Works, Bradford. The total h.p. is 234 h.p. of which 84 h.p. is fitted to the four three-motor cranes, and the remaining 150 h.p. is used for driving the various shops as follows: 25-h.p. air compressor, 15-h.p. plating shop, 15-h.p. plating shop, 15 h.p. special machine, 7½-h.p. corve shop, 15-h.p. fitting shop, 10 h.p. fitting shop, 7½-h.p. chain shop, 7½-h.p. idler shop, 7½-h.p. tool room, 7½-h.p. fan room, 15-h.p. pattern shop.

The pattern shop and stores are in a separate building, which was erected and occupied by workers in the space of a fortnight. It is 60 ft. long, 24 ft. broad, and 21 ft. high. For the works, engine and boiler houses, 54,600 square feet of glass were used, and another 6,950 for the offices. The weight of the iron work employed was 343 tons of steel joists, 323 tons of sectional steel, and about 50 tons of bolts. The area covered by the works is 420 ft. by 150 ft., or 7,000 square yards; by the engine and boiler houses 50 ft. by 55 ft., or 306 square yards; by the offices 270 ft. by 41 ft., or 1,230 square yards, in all an entire acreage of 76,824 square feet.

Of the offices it may be said that they are in every way worthy of the new workshops, no expense being apparently spared to attain efficiency.

AN INTERIOR VIEW AT THE NEW WORKS OF MESSRS. GRAHAM, MORTON AND COMPANY.

THE TRANSATLANTIC ENGINEERING SCHOOLS.

Will they produce results commensurate with the capital outlay connected therewith?

BY

E. C. de SEGUNDO, A.M.Inst.C.E.

The following criticisms are consequent upon Dr. Mullineaux Walmsley's recent paper read before the Institution of Electrical Engineers. The author deprecates excessive elaboration in the equipment of technical schools, and urges the necessity of fostering the students' mechanical instinct.—Ed.

DR. MULLINEAUX WALMSLEY deserves the thanks of the engineering profession for the exceedingly painstaking manner in which he has collated the facts and figures obtained by him during his tour in the United States and Canada, and his paper, entitled "Transatlantic Engineering Schools and Engineering," which was read at a meeting of the Institution of Electrical Engineers on February 25th, will probably form the subject of much useful discussion and criticism.

Every thinking man must realise that the education of the craftsman, whether he be destined to work with his hands or with his head, is an important factor in the commercial prosperity of every country, but at the same time I think that—given suitable capabilities in the individual—the degree of efficiency to which these capabilities may be developed will not wholly depend upon educational facilities.

It is a significant, if disappointing, commentary upon the wonderful development that has taken place in recent years in the equipment of engineering laboratories—both in Europe and on the other side of the Atlantic—that in the large majority of instances it is still true that the men who occupy the more responsible positions in engineering are men who have had, comparatively speaking, small educational opportunities. It may be urged that a sufficient period of time has not yet elapsed to enable one to properly gauge the effect upon engineers, as a body, of the highly scientific training which students can now obtain at moderate fees at most of the leading technical institutions and universities. Be that as it may, I am inclined to think that the present system of technical education tends to aim at accomplishing too much and seeks to substitute information of the nature of "book learning" for the mechanical instinct and maturity of judgment, which can only be obtained by actual experience in the every-day practical work of overcoming difficulties and solving problems of all sorts.

One's education is made up of two parts, that part that is given to one, and that part that one acquires after leaving the training institutions. Of the two, the latter is the more important, particularly in such a profession as engineering. Obviously, the first part of a student's education should be designed to place him in a position to continue his education himself in the most useful manner possible. If a student could map out his future with any degree of certainty, he would be able—in consultation with the various professors—to decide upon the curriculum which would include the subjects with which he intended to occupy himself in after-life, and he would also be able to decide how far each of these subjects should be usefully pursued while in the training institution. Unfortunately, with comparatively few exceptions, it is not possible for an engineering student to foresee in what particular branch of engineering his energies will in the future be exerted, and consequently the engineering curriculum in most technical colleges is drawn up with a view to do the greatest good to the greatest number. The course of study is suggested by the professors in consultation, no doubt, with manufacturers, employers and others, but the very endeavour to include in the curriculum the treatment of a sufficiently varied number of subjects to give the average man a good average send-off, as it were, on his leaving college, threatens to defeat its object by embracing too wide a field and by carrying the treatment of the various subjects up to too high a plane.

I think it is possible that something of this sort may have been in Dr. Mullineaux Walmsley's mind when he wrote the following words on page 23 of his paper. He says, "Another class, from which the engineering colleges of America

draw quite an appreciable proportion of their strength in earnest and capable students, is furnished by those who, not having been able to afford the luxury of a college training in early life, have acquired by dint of hard work and perseverance, or by some stroke of good fortune or inheritance, sufficient capital or resources to enable them to face a four years' college course, and thus to complete a training which was prematurely interrupted earlier in life. It is not too much to say that these men, with their practical experience of life and its troubles, form a very important background to the whole student class of the colleges. From the necessities of their previous practical training it follows that they are men endowed with grit and perseverance, who, having come to college with a well-defined purpose, do not intend to allow any obstacles to interfere with their aim, and thus they form a valuable nucleus round which the more earnest work of the institution gathers."

There can be no doubt whatsoever that if a man has a definite idea of the particular course of study which he should pursue in order to fit himself for the carrying out of duties which he can clearly see and define, he will learn more that will be of use to him in a week than a student equally endowed intellectually would learn in a year in the process of pumping general information into himself—or having it pumped in for him.

In the discussion which followed Dr. Walmsley's paper, Mr. Cooper adverted to the significant fact that no employer had taken part in the discussion. It would certainly have been very interesting, and I think important, to have had the views of those who have employed engineers turned out by the training institutions as to their general efficiency and value. In fact, it is only in consultation with those who have to put the finished product to practical use that useful information can be obtained in modifying or altering the courses of study laid down for engineering students at the various technical and other colleges, and, indeed, it is to be hoped that a conference between professors and employers will be arranged to discuss the very important question suggested by Dr. Walmsley's paper, namely, whether it is really necessary for us to spend the enormous sums in the equipment and maintenance of technical institutions in this country that have been spent in America, Germany and elsewhere in Europe in order to maintain the same standard of mechanical efficiency for English engineering students as, it is alleged, is to be found on the Continent and in America.

I enjoy the privilege of having obtained my theoretical training under one of the most able and practical professors of engineering of recent times, namely, Dr. Alex. B. W. Kennedy. It is not too much to say that some twenty-two years ago the engineering laboratory at University College, London, was better equipped than that of any other institution in this country, and that it is mainly due to Dr. Kennedy's untiring efforts that the value of a properly-equipped engineering laboratory as an adjunct to the theoretical training to be given to engineers became recognised throughout the country, and, I venture to say, throughout America. Although Dr. Kennedy was very much hampered in the equipment of his laboratory by the smallness of the funds that the authorities of University College placed at his disposal, I am inclined to think that the University College laboratory of those days possessed all the necessary tools and equipment for giving the students a very good insight into the practical detail of their theoretical studies, and, I venture to think, that that is as far as the practical training in an engineering laboratory ought to go. It is most interesting to read Dr. Walmsley's accounts of the equipment of the transatlantic engineering schools which he has visited—take for instance, his description on pages 9 to 12 of the equipment of the engineering department of the Cornell Institution. But on reflection one cannot help realising that all the functions of the various machines and apparatus in a laboratory of this description are pre-arranged, and as the machines themselves are, in a sense, kept under a glass case at 60° F., the same results invariably follow the same causes, which, although a strictly accurate philosophical axiom, does not somehow seem to be borne out when one gets down to practical work with machines outside of the engineering laboratory.

I cannot help thinking that the tendency of excessive elaboration in the equipment of technical schools is to form the idea in the student's mind that success in his future work as an engineer will be largely a matter of applying formulæ, whereas the object of an engineering student's training should be to instil into his mind correct fundamental principles, to develop the habit of accurate observation, quick discernment and rapid deduction. To teach him to be always alert, always ready to learn, always inquiring into the reasons of any apparent discrepancy between cause and effect, and thus to continuously develop that most valuable, in fact, absolutely essential characteristic of the useful engineer, namely, the *mechanical instinct.*

THE ORGANISATION OF COAST DEFENCES.

BY

CAPTAIN C. G. VEREKER, R.A., "*Duncan" Gold Medallist, 1903, and* CAPTAIN C. S. S. CURTEIS, R.G.A., "*Duncan" Silver Medallist, 1903.*

Assuming the probability of raids by a foreign naval Power, what are the best preparations to repel them so far as the construction, armament and organisation of our coast defences are concerned. The question is one that has been freely discussed of late both in connection with events in the Far East and also by those who think that our coast defences are capable of great improvement. The following extracts from an essay contributed to the " Journal of the United States Artillery," refer primarily to the American seaboard, but also include much that is applicable to the coast defences of the British Empire. We therefore consider them of sufficient importance to be dealt with practically *in extenso.*—ED.

IN the following article we assume the probability of raids by a foreign naval power. Most people agree that torpedo-boat attacks are likely to take place during the earliest stages of a war, and even in some cases before war is officially declared. At this period it is probable that the reserve ships would be mobilising and squadrons collecting and preparing for sea, and the moral result of a successful raid would be very great. An energetic enemy would spare no trouble in carrying it out, and would not hesitate to sacrifice a few torpedo-boats when even one getting through the defences might do incalculable harm.

The different classes of coast defences and the form of raid to which each is most liable can be summarised as follows :—

Class of defences.	*Most probable form of raid.*
Fortresses at home ..	By torpedo-boats.
Fortresses and coaling stations abroad.	By torpedo-boats (if within reach of an enemy's port). By strong force, if command of sea temporarily lost.
Harbours of refuge at home.	By cruisers or torpedo-boats and pinnaces carried by cruisers.

As each port should be so armed and organised as to be best prepared to meet the most probable attack, it will be convenient to discuss each separately and in the above order.

FORTRESSES AT HOME.

DEFENCE AGAINST TORPEDO-BOAT RAIDS.

In order to divorce our thoughts from preconceived notions and existing works, it will be well, for the sake of discussion, to take an ideal case of a harbour with a narrow entrance to be defended against this class of attack, and to examine the various means of defence which might be available, and the most suitable organisation. We may then be better able to see in what way existing works and schemes of defence might be improved.

BOOMS.

A boom or obstruction of some kind across the channel is essential if we are to be at all sure of preventing torpedo-boats getting through.

No matter how good the gun defence and the lighting arrangements, if the boats only attack in sufficient numbers some are certain to get past, and, if unimpeded, could run clear into the harbour.

It scarcely comes into the subject of this article to discuss the various forms of booms, but the ones now in use should, we think, be quite good enough to achieve their purpose of at all events impeding or delaying torpedo boats.

The position of the boom necessarily affects the position of the guns and lights, and though it would usually be placed at the narrowest part of the entrance, other considerations might make it necessary to put it elsewhere and to employ a longer boom, or narrow the channel by breakwaters or the erection of " dolphins," permanently closing part of the shallower waters.

MINES.

Mines are not as a rule employed in defence against torpedo-boats, they have other and more important work to do in acting as a deterrent to the attack of larger ships, and should not be fired on the chance of sinking such a small and fast moving target as a torpedo-boat, thus leaving a blank in the mine field. But there is one contingency which we must keep in view and which may make the employment of mines in narrow waters very necessary in the near future, and that is the possibility of being attacked by submarine torpedo-boats. Such an attack could not be repelled by gun fire, a boom, unless specially constructed, would be of little use in preventing their entering a harbour, and mines may prove to be the best weapon of defence against them.

ELECTRIC LIGHTS.

The arrangement of the electric lights is one of the most important factors in a successful defence and one of the most difficult to decide upon. The present recognised method is to have an illuminated area in front of the boom, and advanced lights termed " sentry beams " and " searchlights " through which boats must pass before they reach the narrower waters near the boom. All things considered, this appears the best arrangement, as timely warning of the approach of boats can be given, and they come under close range fire as soon as they enter the illuminated area.

The scheme so often adopted of having guns and lights on both sides of the channel is, however, not always satisfactory, though sometimes necessary owing to the breadth of the entrance.

In the ideal case under consideration, it would be better to keep all the lights as far as possible on one side, thus giving a complete belt of light in front of the boom without any of the beams crossing each other. The most advanced of these beams should be able to light up the water close to the shore to prevent any chance of " creeping," and if it were found that the lights would not illuminate the far shore sufficiently clearly, a beam might be placed as shown by dotted lines in the sketch on page 324, to light up thatside of the entrance.

The beam nearest the boom should be capable of being turned upon it, to light it up in case of an attempt

should be their normal position, which will give accuracy with auto-sights up to about 1,600 yards.

The high siting of guns may sometimes give what is called "dead water," upon which they cannot be depressed if the banks are steep and deep water comes close to the shore. In such a case it will be necessary to have one group close to the water's edge for the special purpose of covering this "dead water" area and preventing "creeping" by torpedo-boats.

As the batteries are not intended to withstand a a heavy fire, they will not require any great amount of protection, and as they will be used chiefly at night, they should be of very simple construction. There should be no lifts from the magazines to the gun floor, and steps should be avoided as much as possible. Ample recesses should be built around the emplacements to hold all the ammunition likely to be required in action. Special attention should be paid to the sleeping accommodation for the detachments, as if they do not get good rest during the day they cannot be alert and up to the strain of continuous night work. There should also be small shelters by each gun, so that a few men may always be in readiness to open fire the moment the alarm is given.

All batteries should have a slight infantry parapet in rear and should be entirely surrounded by an unclimbable fence to prevent any chance of their being rushed. If commanded by high ground within about 1,800 yards which might be occupied by a landing party, they should have a parados or a high wooden palisade to screen the detachments from rifle bullets. They should, also, if necessary, be made with a strong traverse on the sea flank, to protect them from enfilade fire by a ship assisting the torpedo-boats. This traverse would also, to a certain extent, prevent "blast" from interfering with other groups.

ORGANISATION.

As a torpedo-boat raid is the one we must be best prepared to meet, and as it may take place before mobilisation has been completed, it is important that everything should be done in peace time to keep the defence ready for immediate action.

To obtain absolute efficiency, the defence against torpedo-boats should be considered quite separately in all general schemes of defence. All the light quick-firing guns and the electric lights should be controlled by one officer, who would organise the defence in peace time, train the men in their work, and command them in war. He should have under his orders at peace manning, and on war mobilisation, not only the R.G.A. to work the guns, and the R.E. to work the lights, but also any infantry told off for the special protection of lights and batteries, and men told off to lay and work the boom.

It is more than probable that small parties will land and attempt to destroy the lights or silence the guns in conjunction with the boat attack. The protection of landing places, and the action of the infantry comes more under the general defence of the fortress, but, as, in spite of all precautions, a few men may creep through unobserved, the "torpedo-boat defence" must possess an independent organisation for its own protection at close quarters. Here again is an advantage of having all the guns and lights possible on one side.

The batteries should be able to protect themselves by carbine or machine-gun fire; the electric light emplacements and engine rooms, etc., should be surrounded by parapets and unclimbable fences, and have a small guard of infantry, and possibly Maxim guns if at all isolated; the boom should be protected by a small work or loopholed wall at each end, the men in charge of the boom being reinforced, if necessary, by a few rifles (*see diagram*).

FORTRESSES AND COALING STATIONS ABROAD.

These, if within range of a torpedo boat raid, are as liable to this form of attack as our home fortresses, and the foregoing remarks as regards the preparation to meet it apply equally.

But they must also be prepared for a raid on a much larger scale, especially the smaller and more distant and isolated coaling stations, and should be armed and organised accordingly.

Mines and Brennan torpedoes are likely to play a very important part in the defence and in preventing ships coming in to close range, but space does not allow a discussion of their merits as we are in this essay more particularly concerned with the artillery defence.

ELECTRIC LIGHTS.

These must, of course, be established for the protection of all defended harbours at night, whether the harbour be exposed to a regular torpedo-boat raid or not, as an enemy may send in boats and pinnaces during dark to reconnoitre, to countermine, or for other purposes.

The general remarks on the placing of lights already under the heading "Fortresses at Home" hold good, except that instead of having a lighted area in front of a boom, the inner lights would be arranged to light up the mine fields.

The outer searchlights would have an important work to do in preventing an enemy's ship getting in close to the works unobserved, for, although it is agreed by most authorities that ships are unlikely to attack at night, it is nevertheless extremely probable that they will make use of the darkness to get in as near as possible, in order to open fire on the batteries at close range at dawn, instead of steaming in, in broad daylight, exposed for 8,000 yards or so to a far more accurate fire than any they can return.

Existing lights would appear unequal to lighting up even large vessels at anything over 2,000 to 3,000 yards except under very favourable conditions and it may, in some cases, be found advantageous to send out vessels fitted with searchlights to assist the defenders in discovering the approach of ships.

GUNS.

We do not require many guns in coast batteries, but what we have should be the very best and highest velocity available. Modern ships are very strongly armoured, and unless we can penetrate their armour we cannot effectually cripple them, although by a rapid fire at the upper structures we may make them draw off.

Quick firing is very important, especially with the lighter guns, which may have but a small and fast moving target exposed for a very short time, or may be opposed to the lighter guns of ships at close range, when speed in firing will be essential.

With the heavier guns, a rapid rate of fire may also be necessary. It is the opinion of many naval officers that if ships engage forts, they will attempt to steam in at full speed to close range and then anchor, when the larger number of lighter guns they carry, and their better armour protection, may give them an advantage

over the open shore batteries, which will be overwhelmed by a superior volume of rapid fire.

It may therefore be imperative for batteries to try and stop ships before they can get to close range, and fire will have to be opened at about 10,000 yards and gradually increased in rapidity as the range shortens and accurate laying with auto-sights, with which presumably all modern guns will be fitted, becomes possible.

To enable an accurate fire to be opened at these extreme ranges the guns must have a high initial velocity.

The projectiles from the heaviest guns should be capable of penetrating the belt armour of modern vessels at, at least, 2,000 yards, and those from medium guns should be able to pierce the armour of, and destroy, the secondary armament.

WORKS.

The introduction of high velocity guns and high explosive shells on ships sealed the doom of the elaborate granite forts, tightly packed with muzzle loaders, which figured so prominently in our coast defences, and the tendency now is to keep to works of simple trace, made as inconspicuous as possible, and armed with a few good guns.

Owing to the long range now obtainable from guns, the batteries need no longer be kept close to the water's edge, but can, if necessary, be withdrawn and placed on higher ground.

The adoption of automatic sights has made it important that guns should be mounted as much above the sea as possible, and where no high ground is available, an artificial mound is raised, or the old forts are made use of as a substructure on the top of which modern ordnance can be placed.

Besides the greater accuracy in laying, range-finding, and observation, obtainable from high sites, they possess every advantage for the heavier guns; these become less liable to be hit by an enemy's projectiles, as ships cannot come in to very close range or their shell would pass over the batteries without doing damage, and at long range their fire is not likely to be very effective.

At any but very close ranges, coast defence guns possess an enormous advantage over ships, owing to their firing from a stable platform.

The latest works built afford, for the most part, good protection to the guns and detachments, but we still do not appear to recognise the importance of protecting the executive officers and the communications. One sometimes sees the battery commander, and his range-finders with practically no cover at all, telephone wires exposed, and dials in the open where they could not remain five minutes under fire.

On board ship the executive officer is in an armoured conning tower, sometimes as strongly armoured as any part of the ship, his means of communication are close by him, and the wires, etc., are led away in armoured tubes.

Are not these precautions equally necessary on shore? Although the B.C. and his staff are nowadays no longer so indispensable as heretofore, and the guns can, if necessary, be fought just as well without them at close range, the effective direction of fire in the preliminary stages of an engagement still depends entirely upon them, and as long as they are found to be necessary they should be protected.

We therefore think that the B.C.'s post should consist of an armoured emplacement or cupola placed in the most commanding position in rear of the centre of his guns, where he could see what was going on, observe his fire and pass his orders without delay. His D.R.F. instruments should be close by him, as it is no longer necessary to place them on the flanks, owing to the introduction of smokeless powder; the instruments themselves should be of an "overhead type, in order that they and the detachment working them may be safe. All telephone wires, speaking tubes, etc., should run direct into and from the B.C.'s post, and when not buried at least a yard deep should be carried in steel pipes; all range indicator dials of the present clock-faced pattern and "figures" should be relegated to the scrap heap, and reliable electric range dials and order dials introduced, so that the whole of the communications may be under cover.

Another point requiring consideration when constructing new works, is the nature of ground used on the outer slopes. This, if of a crumbly nature, causes clouds of dust to obscure the view of the guns even at peace practice, and when thrown about by the bursting of an enemy's high explosive shell, might make it quite impossible to carry on direct fire at all; if shingly, it may make things quite uncomfortable for the gun numbers in action, though this would be the lesser of the two evils. A heavy soil well bound together by surface roots or grass would appear the most suitable for the purpose, but would rarely be available at foreign stations.

The drill book recognises that at close range, owing to dust and smoke from the enemy's bursting shell, it may be impossible to lay the guns over the sights, and to meet this eventuality it has been found necessary to retain position finders, placed some distance away from the batteries, so that the guns may be fought by Case III. from under cover. The cells for these instruments will require very careful screening, more so than is sometimes the case at present, in order that an enemy may be unable to ascertain their position even at a short distance, as otherwise he will no doubt do what he can to render them untenable.

The ammunition supply to guns is a very important detail to attend to. It is pretty well recognised that it would, in these days of rapid fire, be inadvisable to attempt to supply guns in action direct from the magazines by lifts, but that all the ammunition likely to be required will have to be previously brought up and placed handy in recesses near the guns. It is therefore necessary that these recesses should afford ample room for the storage of a plentiful supply, be easily get-at-able, and be well protected from an enemy's fire.

Batteries should be well defended on the land side, for whatever the action of the ships, there can be no doubt that if the destruction or capture of the works is aimed at, landing parties will play a very prominent part, and their success or failure will probably decide the ultimate result of the raid. Every battery should be a self-contained fortress, if at all isolated, and its safety should not depend entirely upon the advanced infantry; it should have a good infantry parapet, be surrounded by unclimbable fences, entanglements, abattis, and other obstacles, have a clear field of fire, defiladed by a parados or by traverses if the interior or the guns can be commanded by high ground, and in fact be made as impregnable as modern fortification can make it.

ORGANISATION.

The reduction of the number and types of guns used, and the introduction of auto-sights will very greatly affect the organisation for defence.

This must be as simple as possible and the main object kept in view must be decentralisation of

responsibility and the encouragement of individual initiative.

There must be one supreme head of the defences on both the sea and land fronts, but section commanders and fire commanders should be reduced to a minimum, and battery and gun group commanders should be prepared to act upon their own responsibility without waiting for orders from higher authority, for, under modern conditions, there will be little time to spare between the sighting of an enemy and the opening of fire. All orders as to selection of targets and distribution of fire should be arranged in peace time, and frequently rehearsed, so that when the attack takes place each individual may understand exactly what is required of him and act without hesitation.

In any case the higher commands must gradually become of less importance as ships approach the batteries, until, when these are within effective auto-sight range, we may expect to find each gun acting independently and correcting its own fire. It is absolutely impossible for a B.C. or G.G.C. to make himself heard, or to pass orders, if three or four quick-firing guns are firing with any rapidity, and it is to be hoped that this may before long be recognised by our drill books, and that our men may be trained in the observation and correction of fire of each gun by its gun captain and layer whenever auto-sights are used. This system has already been tried at practice and found to work very well; it will, however, entail a much higher standard of intelligence on the part of our N.C.O.'s and men, more care in the selection of gun-layers, and a thorough knowledge of the guns and mounting in use.

GUNNERS.

Gunners should be given that work for which they are best suited physically. Quick-firing gun drill requires men with a quick, active physique, not necessarily big men, but hard, wiry men of middle weight, who can move quickly and can last. Fat and clumsy men are utterly out of place. Selection of men of suitable physique has much to do with the maintenance of a high rate of fire.

When gunners are first called upon to defeat an enemy's raid, with the alternative, in the event of failure, of perhaps millions of dollars worth of *materiel* lost to the nation, the all important man will be the gun-layer. He will be at his gun waiting, see a torpedo vessel enter the beam perhaps at over 20 knots an hour, and have to stop that boat while it is under his fire, perhaps for one or two minutes only, if that in some cases. What conditions can be more calculated to upset a man's nerves, to make him in fact lay his gun less accurately than usual? Some men have a natural genius for gun laying, are always sure of themselves, have a marvellous control over elevating and traversing numbers, and always keep cool. We see it in the tests to which we put them in peace time, when they consistently lay a gun accurately in about half the time the average layer takes. Yet we let these men go when their time is up. We make no more effort to retain them than any ordinary man.

Every gun has its own peculiarities, and it is just as necessary for a detachment to know their gun as for a sportsman to know his, or an infantryman his rifle. As at stations abroad, the men required to work the guns are, or ought to be, always on the spot, it could be easily arranged to have a number of them told off to each gun and to get them to look upon it as their own particular weapon, much as is done on board ship; they should be responsible for keeping it cleaned and in working order, for mounting and dismounting it when necessary, and should always keep to it at drill and use it at practice and in action.

HARBOURS OF REFUGE.

The defence of these calls for few further remarks. Most of what has already been said under the previous headings applies to some extent in this case.

Although it will rarely be feasible or desirable to close the entrance with a boom, there must be a good proportion of light quick-firing guns in the armament, and electric lights must be provided, in order to prevent raids by small boats during dark. The defence might be greatly assisted by a line of anchored barges or pontoons carrying quick-firing guns, if the entrance is at all broad, an illuminated area being established just in front of these, but any form of floating defence should be avoided if possible as it is likely to interfere with the freedom of fire of the land guns.

If larger vessels attack they will probably be cruisers or "commerce destroyers," and to meet these an armament of 6-in. guns should, as a rule, be good enough, with perhaps a few heavier guns to deal with a possible attack by armoured cruisers or battle ships, and keep them out of bombarding range of the shipping.

These defences are not intended to stand a determined attack, and there is no necessity for overdoing their armament, but the few guns provided must be the very best.

An attack by a landing party being extremely probable, as some harbours of refuge are somewhat isolated, and as a large force may not be available for their protection, the batteries, while made safe from a sudden rush by means of the usual parapet and unclimbable fence, must be further guarded by small infantry redoubts occupying any high ground within range of the rear of the batteries, and which might be occupied by the enemy with a view to keeping down the fire of the guns while the attack on the shipping in harbour is made. The landing places should also be guarded by small redoubts, which might with advantage be provided with one or two 4·7-in. guns able to fire shrapnel shell at any boats attempting to land men.

No elaborate organisation or chain of command is necessary, as, if attacked, there will be little doubt about what to do and how to do it, provided definite orders and instructions have been issued beforehand.

The garrison should consist in great part of local Militia and Volunteers, who will take a personal interest in the defence of their port and homes, will know the coast and surrounding country, and can be trained in peace at the work they will carry out in war, so that on mobilisation there will be no delay, and the port will be placed in an efficient state of defence against raid before the declaration of war.

FRENCH ENGINEERING PROBLEMS.

BY EDWARD CONNER.

TWELVE months have elapsed since deputy Aimond presented his very able and comprehensive report upon the actual conditions of engineering in France, as compared with that in other countries. Disheartening as this document was at the time, it was entirely free from exaggeration. The state of engineering in France was shown to be gloomy indeed, the cause of the prevailing industrial depression being attributed partly to want of capital urgently required to carry on modern improvements, and partly to the lack of energy displayed by his countrymen, the majority of whom had not yet become convinced of the imperativeness of looking ahead, and of visiting neighbouring countries for the purpose of acquiring new ideas.

It is indeed a very great pity that engineering France has so little capital at its command, and that so many excellent and practical suggestions have to remain inert in consequence. Not a day passes but canals, rivers, and harbours throughout the country require something done to them, because found inadequate for the commercial development of the country. As compared with the neighbouring continental states, France cannot show much work done, though she has indulged in a great deal of patchwork, so hampered has she been by financial difficulties.

In the course of an engineering tour through France, weak points seem to crop up here, there, and everywhere. To begin with, the northern section, which is, indeed, a very important artery, one is surprised to find that the metallurgic region of Eastern France is in no way connected with the North Sea; in other words, this very wealthy part of France is absolutely dependent upon Antwerp. How serious this is from a maritime point of view can be easily imagined when it is found that the same region is equally dependent upon Germany as regards inland transport. It will be easily seen how urgent it is for the French Government to construct as quickly as possible a navigable way, which will render France independent of these neighbouring States, and enable her to convey her large consignments of coals from the Pas-de-Calais to other parts of Eastern France through French territory. A project of this kind has been under consideration for more than two years; French political disturbances, and almost incessant changes of Government, have, however, prevented the scheme from reaching maturity.

The two canals in question, which will, it is to be hoped, before many more years be completed, are the Chiers, connecting Longwy and the Meuse, and the Canal de la Meuse, which will be made to join the Escault. When these two canals are inaugurated the French engineering world will have every cause to warmly congratulate itself. That the industrious inhabitants of the Pas-de-Calais, and Nord departments should display impatience at the delay on the part of the Government to provide them with such outlets is only natural; no one knows better than they do how beneficial and indispensable these two highways will prove. Let it be said, *en passant*, that when terminated, communication between the North of France and Paris, by the already constructed canal of St. Quentin, will increase considerably.

It is with unfeigned interest that we turn to the Valley of the Loire, the most fertile spot in Western France. The efforts made some years since to transform that majestic river—the Loire—into a navigable stream, have not yet been crowned with success. Such a task is in any case "freighted" with difficulties, which time only can overcome. The Government, we are aware, is willing to experiment none the less, and deal with the vexatious problem by degrees. That part of the Loire situated between Nantes and Angers will be the first to receive the attention of engineers; were that small section to at last become navigable, it would alone be worth its weight in gold, as it would afford a *débouché* to minor tributaries, important in their way, such as the Loir, la Sarthe, and the Mayenne.

Proportionately speaking, Nantes has proved the most prosperous of its kind of late years to France; no other sea-port having been able to report progress in so little time. Official statistics inform us that its tonnage, from being 354,000 tons in 1890, rose to 1,176,000 tons in the space of nine years—almost a record, so far as French shipping is concerned. This phenomenal success was solely due to the construction of the maritime canal from La Martinière to Carnet. The moral of this once more indicates that the best way to create commercial animation in any growing centre, however small, is to pave the way in advance, rather than wait until increasing demands of traffic make it imperative to start such operations.

The Bassin du Rhône is also another important hive of industry which awaits engineering development. The French maritime world is anxiously looking forward to the day when Marseilles will be able to hold its own against its rival—Genoa; engineers have stated that this could easily be done, and at little cost moreover by establishing a direct connection between Marseilles and the Rhone, which flows through a wealthy district. After all, the river Rhône is really the *tête de ligne* or starting point, and very proud are the local inhabitants of the fact. Unfortunately, the Government regrets for the present to be unable to create such a link, though it is occupied with completing projects voted as far back as 1868; these schemes comprise the connection of the Rhône, *via* the north, to the Loire; and the latter in a southerly direction to Marseilles and Cette. Other plans must wait. No objection is raised to this, provided the State does not overlook the joining of Marseilles to the Rhône—a project which must be achieved some day, it having become an undisputed commercial necessity.

All the money that the Government can conveniently devote to maritime schemes it does unhesitatingly, as will be seen. Millions are actually being expended on the principal sea-ports of the country. Dunkirk is undergoing a complete change; the mouth of the harbour is being deepened and enlarged in a general sense of the word; several new ship-yards are being built, to say nothing of other necessary improvements, the total cost being estimated at over 30 millions of francs. The same remark applies to Dieppe, on which port 11 millions of francs more will be expended. Another 20 millions of francs have been voted for bringing Havre up to modern requirements; 23 other millions are to be spent on Nantes for the same reason. The aim in view in each case being to enable vessels of a larger tonnage to enter the harbour.

The contemplated ameliorations in the port of Bordeaux will entail an expenditure of at least 14 millions of francs. Boulogne-sur-mer, Cette, Bayonne, etc., will also be overhauled in due time, regardless of expense.

Enormous as these various outlays appear, they have been as economically studied as possible; the nation insists that the State should continue to spend large sums every year in order to avert commercial decline. France is still a first-class power, and, as such, must either follow the lead of other nations on an equal footing with herself, or collapse.

FAMOUS TECHNICAL INSTITUTIONS.

III.—The Birmingham University.

BY

C. ALFRED SMITH, B.Sc., A.M.I.E.E.

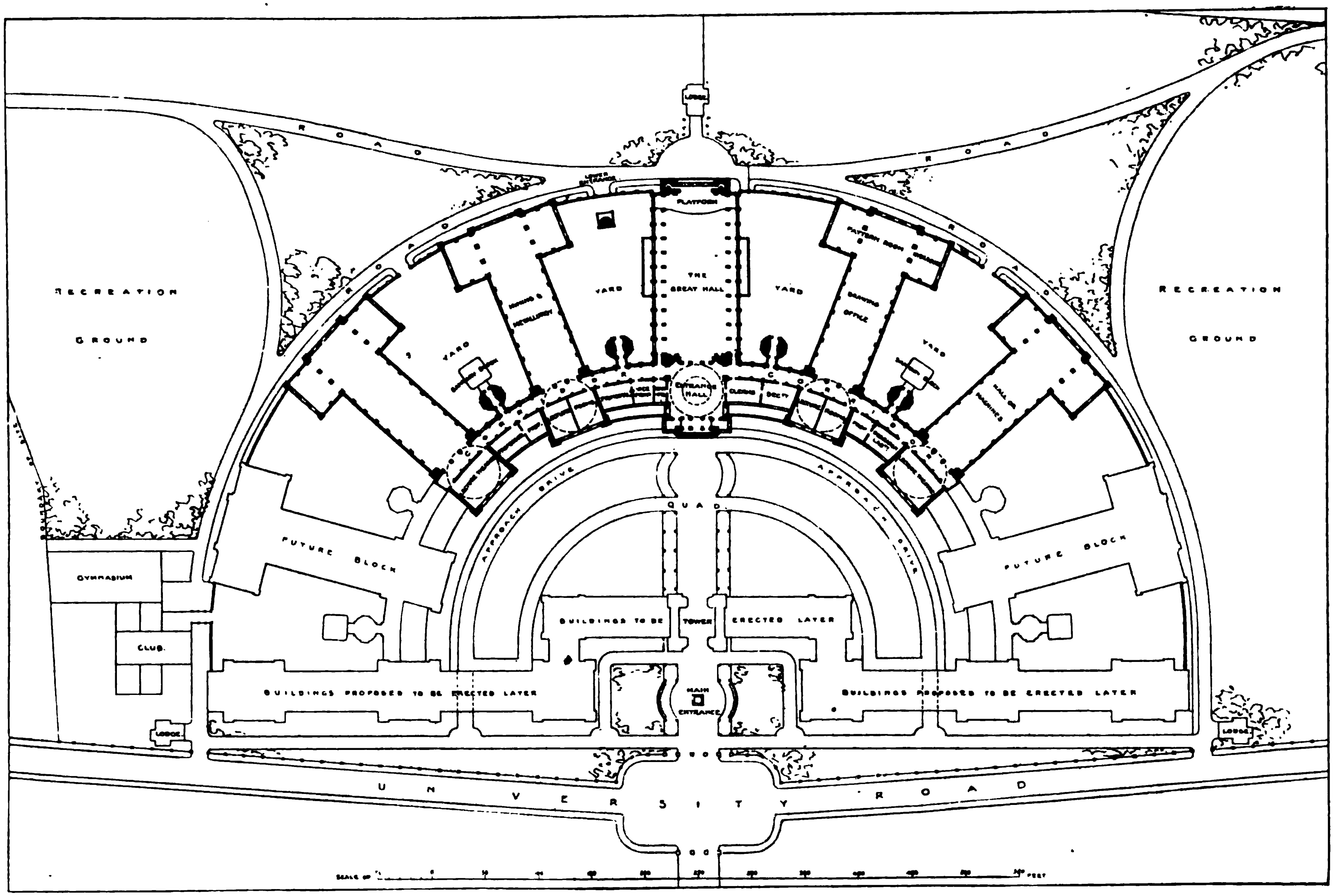
The fourth of a series of articles describing prominent technical institutions at home and abroad. The Massachusetts Institute of Technology was dealt with in the January number of Page's Magazine, and in the following issue Mr. C. A. Smith commenced the description of the Birmingham University, which is now concluded. The February instalment included details of the power station; in the March issue the author turned to the foundry and forge and the huge laboratories and workshops known as the main buildings. In the present article he discusses the metallurgical, smelting and furnace section. For many of the illustrations of the Birmingham University we are indebted to the Editorial Board of the "University Engineering Journal."—Ed.

Part III.

THE METALLURGICAL SMELTING AND FURNACE SECTION.

Commenced a year after the power station, this structure will now be complete in the course of a few weeks. This building, which is 125 ft. long, 50 ft. wide and 28 ft. high to the roof principles, is lighted at the top, and is well ventilated by a top louvre and cross ventilation. It is divided into four shops, the two large ones being each 50 ft. square, and the two smaller ones 25 ft. square. In the former the dividing walls do not reach to the roof and a good circulation of air is therefore assured. One of the large shops is exclusively for steel melting, the other for treating ores of gold, silver, copper, lead and any other non-ferreous metals. For the steel melting there is a two-ton new form of Siemen's regenerative furnace, built by Frederick Siemens, of London, with the necessary gas producer, lift and casting pit, the furnace being also arranged for experimental work with Mond gas from the power station. There is ample room for further appliances which will be added later. In the non-ferreous smelting house, ranged along one side of the room, there are a circular water jacket cupola blast furnace for melting copper and lead ores, an English cupellation furnace, a Brukner revolving calciner, and a roasting furnace for dealing with various kinds of ores. Along the other side of this room are placed the storage, leaching, and settling tanks and a lead-lined chlorination barrel for the wet treatment of gold ores. The whole of this apparatus is designed and supplied by Messrs. Fraser and Chalmers, London. Of the two small shops, one is ultimately to be devoted exclusively to that new branch of applied science which is making such rapid progress—electric smelting—while the other is to be a small experimental steel and brass foundry for pot furnace work. Four holes will be provided in this foundry, two for steel and two for copper alloys. This portion of the equipment is being provided by the Morgan Crucible Company, of Battersea, London. A special feature of the design of this building is an outside flue 4 ft. 6 in. high, inside measure, which leads from the smelting plant to a stack which will serve for all the smelting work. It is arranged for the collection of flue dust and the recovery of precious metals therefrom, and is specially constructed so that the students will be able to thoroughly inspect it, a detail which is seldom taken into consideration in ordinary work, but which is very desirable. This building is believed to be a more lofty, better lighted, and more complete and compact one than at present exists anywhere for metallurgical instruction (not even excepting the great American universities). It will be ready for the students by July 1st next, when it is proposed to arrange a summer metallurgical school lasting for one month. This section will be used in connection with the regular teaching during the coming session.

When facing the great hall, the building which is on the left hand is to be used for mining and metallurgy. Students in either of these branches of applied science will also do some work in the subject in which they do not intend to specialise, *i.e.*, the mining students will take special work in metallurgy and *vice versâ*. The lower ground floor of the T-shaped portion of the building is for the mining department, while the main ground floor is for the metallurgical section, the professor in charge of which is a man famous for his discovery of the influence of silicon on cast-iron—Professor Thomas Turner. Although the general outlines are decided upon, so rapid are the new inventions in this work that the Professor is keeping an open mind concerning many of the details, and is arranging his plans so that these can be changed, should he deem it advisable, when the buildings are ready for the equipment. There will be separate and special laboratories for pyrometry; the microscopic examination of metals; and electro-metallurgy—especially with a view to electrolytic work, of which so great a quantity is done in the district. There is a separate balance room which will be large, airy,



From the "Building News."

PLAN OF THE BIRMINGHAM UNIVERSITY.

and well lighted. At the end of the T portion of the laboratory is the machinery required for the preparation and sampling of metals and ores, and also the furnace room for dry assaying and similar purposes, so that all the noise and fumes are well away from the laboratories. The whole of the practical work of this department is on one floor, which (contrary to that in any of the existing universities in America) is above the ground. In the past, cellars have been invariably used out there for housing those engaged in the learning of this science. This block is, however, well lighted on three sides, the windows commanding considerable views of the university grounds and neighbourhood. The large elementary laboratory is also to be provided with additional top light. There will be in this block a large museum extending round the whole length of the centre part of the T with specimens and samples. Professor Turner will be able to accommodate fifty ordinary and ten research students in any one year, and since the course extends over three years this means that 180 students can take the metallurgical course.

THE MINING DEPARTMENT.

In this department, which has been reconstructed recently, and is under the able direction of Professor Redmayne, the instruction will include both branches of mining—coal and metalliferous, as well as surveying. The work done will be of as practical a nature as possible. For this purpose a model coal mine is being constructed, covering nearly an acre of ground. In this mine underground surveying, the manner of connecting underground to surface surveys, the laws governing the ventilation of mines, and systems of ventilating and modes of working collieries will be taught. Method of haulage, operated by gravitation and electrical power, will be in operation in the mine. In addition to this all kinds of safety lamps, mining tools, drilling and boring apparatus, coal-cutting machines, winding and hauling ropes, coal-tubs, etc., will be represented, and will be in constant use by the student for sketching, handling, and experimenting with.

Although the essential mining industry of the Midlands is coal mining, there will be for the benefit of students from the colonies, or those who intend practising metal-mining, a fully equipped metal-mining laboratory, one of largest in the world. This is so designed that all of the processes of treatment of the ore will work, as in actual practice, by gravitation. For this purpose the floor is built on three different levels. On the highest is the crushing and stamping machinery; on the intermediate, sizing and dressing, the settling pans and leaching tubs; and on the lowest the apparatus for the mechanical treatment of the tailings, which include a frue, vanner, a buddle and a wilfley table.

The water, which will be used over and over again, will be kept at a constant pressure by an elevated tank and regulators. This laboratory will be capable of treating ores of tin, copper, silver and gold, and some of the minor metals. The operations demonstrated will be those of coarse crushing, fine crushing, sizing, hydraulic classification, jigging, slime-washing, electro-magnetic separation and lixiviation.

The museum, a large and spacious room, is so situated that the students will have to pass through it on their way to the draughting and other classrooms; the object aimed at being to make them familiar with the contents so that daily object lessons may be presented to their gaze. It will contain, amongst other things, large working models of several classes of mines, parts of actual mining machinery or appliances, such as air-compressing machinery, mining tools, blasting apparatus, ores, and ore dressing, products from different mines in various countries, samples of coals and other fuel from the Midlands and various parts of the world.

For plotting mining and other surveys, levellings, etc., and instruction in mining drawing generally, there is a large draughting room. In the coal-mining laboratory many operations related to coal mining will be practically demonstrated, as, for instance, the working of machine drills, coal-cutting machines, the construction and testing of safety lamps, manner of testing the safety of explosives in gaseous mixtures and coal dust on a small scale, etc., etc. The departmental library, when completed, should form a centralising point not only for local but world-wide mining literature.

In the coal-mining research laboratory, advanced students will carry on the testing of the relative values of fuel, etc., and other research work. There are also two class instruction rooms for advanced students, the one containing printing and photographic apparatus, the other the surveying instruments in use.

The heads of the three great departments, engineering, mining and metallurgy, are men who had already won reputations as experts in their own particular subjects before they went to Birmingham; it is obvious to the most casual observer that they have greatly enhanced this by their unique record chronicled in these articles.

FOUNDRY COSTS: THEIR ANALYSIS AND REDUCTION.

By HENRY HESS.

Mr. Hess describes a simple system of plotting cost records and methods of analysis based on comparison with ideal conditions.—Ed.

IN order to economically manage a foundry it is necessary to know accurately the various elements of expenditure, and, having these, to analyse properly their relation to one another and to the product. The manager is then in a position to check at once any rising tendency of the costs or to bring about a reduction, as the analysis points out an opportunity. No doubt, all of this can be, has been, and is being done successfully to-day by many a foundryman to the entire welfare of the business without any conscious or formal analysis or detail accounting. There are many managers of the old school who, through personal experience, a high order of native talent, and close touch with every detail, get along without other aids. But in these days of large and growing concerns, it is neither advisable nor safe to rely utterly on one man, no matter how capable, nor yet to the best interests of all concerned to burden the higher officials with the infinite detail work needed to get into sufficiently close personal touch with the entire working routine.

It is quite possible so to present the vital elements of cost that the managing head can at once grasp all salient features, see whether cost is stationary or not, and determine where effort must be applied to check a rise or bring about a reduction. The necessary work forming the basis of analysis can be readily performed by a very ordinary grade of shop clerk, once the routine has been fixed.

THE ELEMENTS OF COST.

To start with, all of the elements of cost must be enumerated. It is well also to assign to each element a value, not so much with the idea that this value is absolutely correct, but rather to have some basis of comparison; experience may be relied upon to gradually bring about correct values. The figures given hereafter are to be taken as having merely an illustrative value; no attempt is made to provide a record of actual or proper costs.

In illustration, the elements of cost are divided among a few main heads as follows, it being understood that for actual work a subdivision more in detail must be used; to enumerate them fully is outside the province of this article, in which it is intended merely to present in general outlines a successfully used plan:—

(*a*) General expense.
(*b*) Fixed salaries.
(*d*) Power.
(*e*) Miscellaneous materials.
(*f*) Labour.
(*g*) Pig and other charging metal.
(*h*) Smelting material.
(*j*) Light.
(*k*) Recovered material.

The collating of the actual amounts of the various items as incurred is best done weekly rather than monthly or at other long intervals, as that will permit the recognition of a defect in time to trace it correctly to its cause and to apply a remedy. Should a longer interval be determined on, that should be four-weekly rather than monthly, in order to avoid the disturbing effect of the varying number of working days in different months, and also because it fits in better with the weekly pay accounts. Such charges as are based on a monthly rate can very readily be converted into an annual and from that to a weekly rate.

Apportionment of the various elements of cost to main divisions is made in accordance with readily apparent principles:—

(*a*) General expense: Depreciation and interest charges.

(*b*) Fixed salaries: All salaries to persons having a fairly certain tenure of office; salaries to minor clerks that are likely to vary in amount should be entered under labour.

(*d*) Power: All charges directly connected with the power plant.

(*e*) Miscellaneous materials: Sand, flour, chaplets, wire, molders' implements, etc.; in fact, all materials not accounted for under heads (*g*) and (*h*).

(*f*) Labour: All payments made to workmen and other persons. Includes all pay not taken care of under head (*b*).

(*g*) Charging metal: Everything charged into the cupola, except fuel and flux; also all "medicine," whether added in the cupola or ladle.

Note.—For purposes of comparative analysis these materials should be rated at fixed values, although they will be purchased at more or less fluctuating rates. In order to take care of the difference between the assumed fixed and the actual fluctuating cost, the difference should be determined at suitable periods, and this difference debited or credited, as the case may be, as a "market equaliser" affecting the profit and loss account. Should the fluctuations be large, it will be advisable to make use of a "special charging account" to properly analyse the influence of various brands of iron and scrap on the cost of the charge. Preference is to be given to determinations at short intervals—say quarterly—rather than longer ones, as changes can then be made in time to effect economies.

(*h*) Smelting materials: All fuel and flux charged into the cupola; fuel recovered from the bed is to be charged again into the cupola. Fuel for other purposes, such as drying ladles, cores, and molds, is to be charged under head (*e*).

As the market price of these materials also is apt to vary, and as it is desirable in the analysis to make use of a fixed price, the difference is taken care of by a "market equaliser," as previously explained.

(*k*) Recovered material: This account takes care of all difference between molten iron obtained from the cupola and the saleable castings. It is made up of:—

1. Equipment: Castings for foundry use, such as weights, flasks, chills, etc.

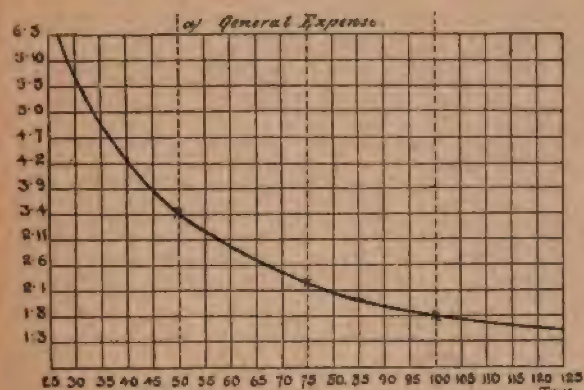
2. Upkeep: Castings made to repair or replace wastage of foundry equipment.

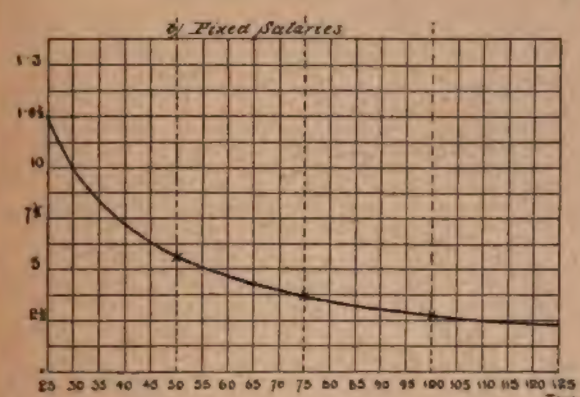
3. Gates: Gates, cast core irons and frames, sinking heads, and sprues.

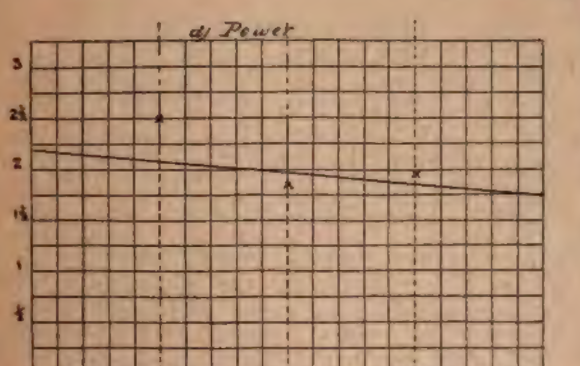
4. Wasters: All defective castings.

All of this material will either be present in the foundry or will be charged into the cupola as scrap. In the latter case it is certainly to be rated only at the same value as purchased scrap. In the first case it is conservative policy to rate the material no higher than scrap, as it is very questionable whether it would bring a higher return if sold.

As the material for producing the items under this head has been entered as a charge, its value should be credited to the total costs in order to give a true net total cost.







(j) Light: All charges directly connected with the shop lighting.

It is to be remembered that the divisions as here cited are merely suggestive of underlying ideas and principles; in actual practice a larger number will be used, and many will be divided and subdivided. The labour charge, for instance, should be split up into direct and indirect labour, etc.

BASIS OF COST PER 200 LB.

In general it will be most convenient to reduce all elements to a basis of cost per 200 lb., or one-tenth ton, as a compromise that avoids the high figures for output when figured in pounds and yet allows ready reduction to the pound rate generally used in the sale of castings.

In comparing costs at different periods it will not do simply to divide the total cost incurred during a week by the total pounds produced during that week and take the result as a pound cost, to be compared with that of some other period. Every manager knows that the cost per pound rises when the product is small and decreases with an increasing output, and will take this into account when comparing costs. But such allowance is made as a matter of judgment only. Now, judgment is a very good thing, but certainty is still better if it can be made to take the place of judgment; in this particular instance that can be done and quite readily. As an example, say that the fixed general expense charge for a week is £333 6s. 8d.; with the output fifty tons, the charge per 200 lb. is then 3s. 4d.; but for a doubled output of 100 tons the charge per 200 lb. would be halved to 1s. 8d. These values, plotted as a curve for various rates of output on the horizontal scale, give the diagram (a).

Similarly, that other element of fixed cost, fixed salaries, is plotted as diagram (b).

Fluctuating elements of cost are also so plotted, though from the nature of the case the curves cannot be determined by direct calculation, but must be approximately laid down in accordance with experience and judgment. In this way the diagrams for power (d), for miscellaneous materials (e), and for labour (f) are laid down as decreasing with an increase in production. Pig and other charging metal (g) and smelting material (h) are laid down as horizontal lines, as these items are not apt to be materially affected by the amount of the output.

All of these curves or lines I term ideal curves. Their total will give an ideal total cost of production, as shown in diagram (i), by the lower line, per 200 lb. of melted iron. If all the iron melted were turned into saleable castings, this lower, or 100 per cent., curve would represent also the cost of saleable castings. The other curves give the cost of saleable castings for the various ratios of such castings to the total iron melted. These curves are determined as follows: Take the total cost per 200 lb. of melted iron as 14s. 2d. the value of recovered iron as 10d, the saleable castings as 80 per cent. Then the 160 lb. of saleable castings would cost as much to produce as the 200 lb. of iron melted, less the value of the recovered iron, *i.e.*:—

	s.	d.
Cost of melted iron .. — —	14	2
Value of recovered iron — ..	0	10
Cost of the 80 per cent. of saleable castings is the balance ..	13	4

and 200 lb. of saleable castings would cost $\frac{13/4}{4} = 16s\ 8d.$

This can also be put as a figure to be added to the cost of the melted iron from the equation

$s = \left(\frac{1}{p} - 1\right)(i - r)$, in which

s is increase to be added to cost of melted iron to give cost of saleable castings;
p is percentage of saleable castings divided by 100;
i is value of melted iron;
r is value of recovered iron.

COMPARISION WITH IDEALS.

Considering in illustration values from diagram (i): The actual cost per 200 lb. of melted iron is 15s. 0½d. 12s. 10½d. and 12s. 6d. in the three periods shown. According to the ideal curve, the lower one marked 100 per cent., these costs should have been 14s. 2d., 12s. 9½d., and 12s. 1d. Running up the first week's cost, the manager finds that of the various items the cost for miscellaneous materials (e) was by far the higher as compared with the ideal laid down, and instructed the foreman to cut this. Next week the total is still found too high; following this through shows that miscellaneous material cost has been reduced actually below the ideal, but that the labour element (f) went up materially; investigation in the foundry showed that the foreman economised on sand mixtures and facings to such an extent as to apparently increase the cleaning labour; the apparent relation between these two elements of cost should be followed up to see whether it is actual. The best way is by a further subdivision of these two elements for some time. As before stated, the analysis is here carried only far enough to explain the idea; nor must the figures given be considered in any other sense.

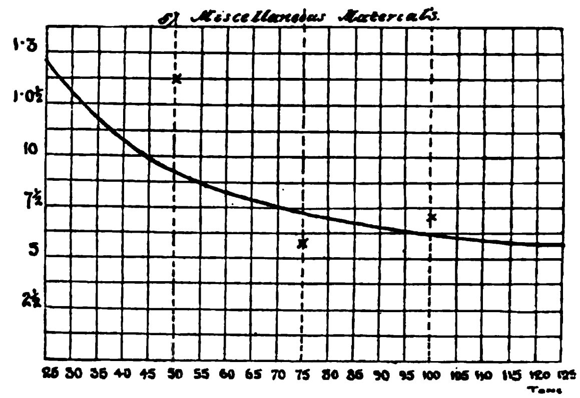
The following week the total is still found high as compared with the ideal, but more nearly satisfactory.

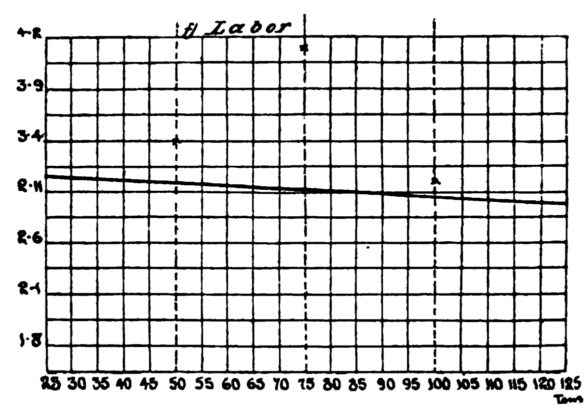
Looking further, the manager finds that the cost of the saleable castings is 18s. 4½d., 20s. 5d., and 13s. 8d. in the respective periods (entered as + points in the diagram), whereas they should have been but 16s. 8d., 18s. 6d, and 12s. 10d., to correspond with the ratios of 80, 60, and 90 per cent. of saleable castings. The very low ratio (60 per cent.) of saleable castings in the second week is entirely too poor a showing to pass without comment. Tracing upward, it is found that the smelting cost (h) was very low, leading to the inference that economy of fuel had led to the very large amount of wasters; investigation in the foundry bore this out, as too dull iron, consequent on the use of insufficient coke, caused a lot of scrapping.

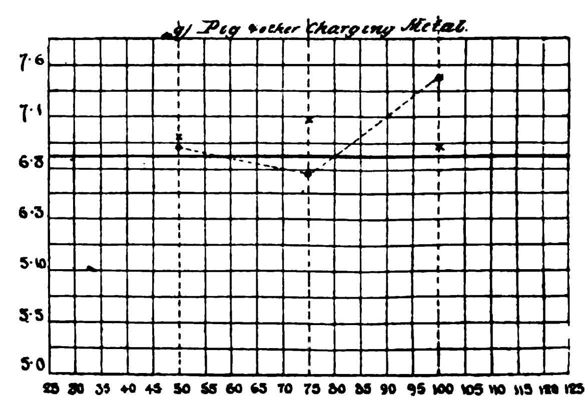
ADVANTAGES OF THE METHOD

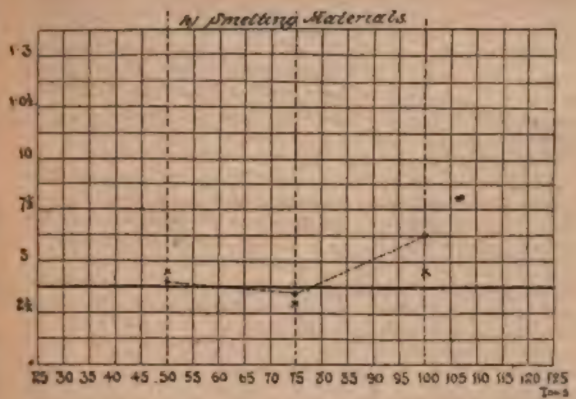
From what has been said it is apparent that this plan of plotting records and methods of analysis based on comparison with ideal conditions keep the busy manager up to date in his knowledge of what is actually going on, not only as regards totals, but also in detail, so that he is always in position to find a sore spot and apply a remedy based on certain knowledge, backing up his judgment. The method has the further advantage of showing whether the remedy applied really did result in the cure desired, or whether it merely brought about a transfer of the sore to some other place.

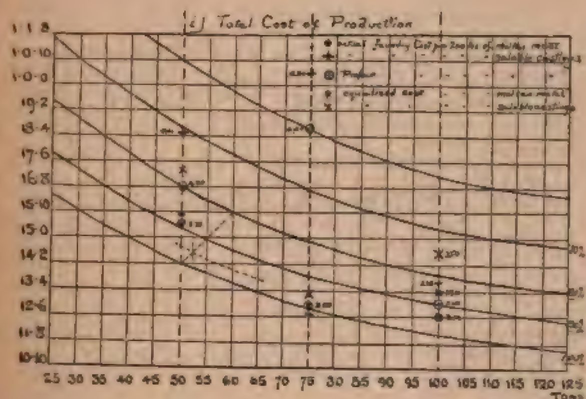
Knowledge of the fact of such close analysis being made will keep the foreman and others responsible tuned up to concert pitch. It has, in my experience, immediately on adoption resulted in a decrease in costs; showing the foremen actual figures will avoid much of the bad feeling easily raised with well-meaning men when their results are criticised. Being human, they are more or less inclined to ascribe criticism to prejudice. Under this method of absolute analysis responsibility will be placed where it belongs, and it will be possible to bestow praise judiciously in the proper quarter—the old adage to the contrary notwithstanding; "soft words do butter parsnips" to the decided advantage of the firm.

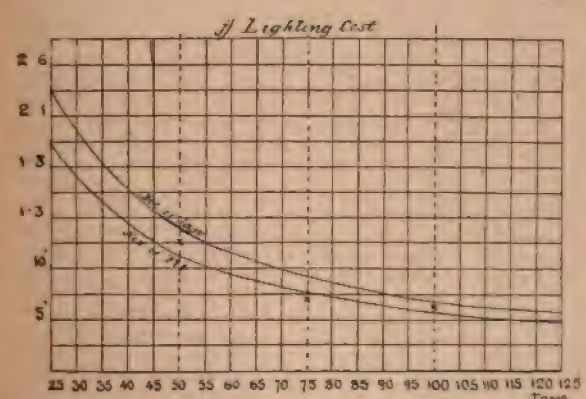












NOTE.—These diagrams should in practice be so bound together that the dotted lines run continuously over the entire series; that will permit a ready tracing of each period's output to the various elements. Plotting books as used by engineers will be found very useful for entering the diagrams.

MARKET EQUALISER.

In enumerating the elements of cost, mention was made of a market equaliser to take into account the fluctuating value of the materials bought; this is brought in as follows: the actual unit value of material used at any time is its average cost price; this may, according to circumstances, be either higher or lower than that due to the current market rate or than the ideal assumed. These actual costs of such material are plotted into the diagrams (*g*) and (*h*) with the sign **O**. The actual total costs as modified by the equaliser are also added on the total diagram (*i*) with the signs * and **X**. Consulting this, it will be seen that a recent purchase of pig and coke at high figures had the effect of raising the cost of the last week's output considerably —from 12s. 6d to 13s. 4d. per 200 lb. of molten metal and from 13s. 8d. to 14s. 7d. for saleable castings. The actual utility of separately considering this element is evident, as otherwise the more nearly satisfactory cost of production, so far as under the control of the foundry foreman, would have been obscured. The actual cost due to the market price of the materials being given will allow sales being based on that.

Lighting has not so far been taken into account as an element of cost; this because it is dependent upon the season and the weather, conditions that are not subject to control. This variable character would to a certain extent impair the value and reliability of the main analysis for purposes of cost comparison. I therefore prefer to plot it as an addendum diagram (*j*), and to consider its influence on costs separately. In determining sales prices this cost item must, of course, be added.

The totalling diagram (*i*) would be too greatly obscured were curves drawn in for more than each 10 per cent. of variation of saleable castings. It is, however, a very simple matter to interpolate points as desired: Say the 95 per cent. line is required at about sixty tons output. Mark the intersection of any vertical in that neighbourhood—say fifty with the 100 per cent. curve—then the intersection of the next heavy vertical at ten tons farther along with the 80 per cent. curve; then of the next heavy vertical, at seventy tons with the 60 per cent. curve; now pencil a curve through these intersections. As 95 is midway between 100 and 90, the intersection of the curve just pencilled in with the vertical midway between those cutting the 100 and 90 per cent. curves will be a point on the 95 per cent. curve sought. This latter may then be continued both ways approximately parallel to the curves between which it lies.

In conclusion, I may be permitted to point out that this method of cost analysis is not by any means restricted to the foundry, but is applicable advantageously to all lines of work in which the cost of production varies necessarily with some other factor; in most lines of manufacture that factor would be the output. Although rather lengthy to describe, the plan is not at all formidable in actual use. All the data required are assumed as available, being needed for any arrangement of recording costs that may be in use, so that there remains only the work of laying down ideal curves, and of plotting in the actual values; this latter operation is a very simple one, that can be quickly mastered by the average costing clerk.

Read before the Engineers' Club of Philadelphia.

NOTES AND NEWS.

MESSRS. ROYCE, LTD., of Manchester, have appointed as sole representative for the London district Mr. E. C. Amos, M.I.Mech.E., 20, Bucklersbury, E.C., from whom all particulars of the "Royce" dynamos, electric motors, cranes, switches, etc., can be obtained.

The British Westinghouse Electric and Manufacturing Company, Ltd., has secured a contract from the Manchester Corporation Tramways for the supply of the complete electrical equipments of a hundred tramcars. The equipments, and in particular the motors and controllers, are of a type which has been developed with much care to meet the requirements of city tramway service, and of which a very large number has been sold.

Messrs. Lobnitz and Co., Ltd., of Renfrew, are to build for the Suez Canal Company a hopper dredger larger than any afloat. This dredger is of the bucket type, and very powerful. She is the seventy-eighth ordered by the Suez Canal Company, and, as hitherto, will be classed with Bureau Veritas. The firm at the present time is constructing another hopper dredger which has buckets each of fifty-four cubic feet capacity, this being also a record size.

It was decided at a recent meeting of directors of the North-Eastern Railway Company, at York, that an extensive installation of Westinghouse power signalling should be installed at the new Paragon Station, Hull, and the contract was let to Messrs. Mackenzie and Holland, of London and Worcester, the agents of the Westinghouse Brake Company. The apparatus will be of British manufacture, being made at the works of the Westinghouse Brake Company, Ltd., King's Cross, London.

The Wimbledon Urban District Council has accepted the tender of the Paterson Engineering Company, Ltd., for a water softener and filter, softened water storage tank, etc., in connection with the extension of its electricity works. The company lately received an order from the British Westinghouse Electric and Manufacturing Company, Ltd., for a Paterson combined feed-water softener and grease eliminator for the Northampton tramway power station, and from Messrs. Dick, Kerr and Co. for the Portsmouth tramway power station. Messrs. Harland and Wolff have ordered one of their condensation water purifiers for removing all oil from the feed water at their new central electric power station. The Paterson Engineering Company Ltd., has opened an office at Amberley House, Norfolk, Street, Strand, W.C.

Admiral Sir E. Seymour, in the course of a speech at the annual dinner of the Institution of Civil Engineers, said he thought it very satisfactory to see that the type of battleships extremely various twenty years ago, seemed to be settling down more into a single type. He was of opinion, as a sailor, that it was a mistake to go on increasing the size of our battleships any more. One reason was that, in these days of torpedoes and submarine mines and boats, it was putting too many eggs into one basket. He thought that the size of the battleship was a thing that should be somewhat limited. Referring to the war, he said that he knew some of the localities and one or two of the actors. As far as it had gone at present, it bore out the words of Bacon three hundred years ago, "He that is strongest at sea has had great liberty, for he may take as much or as little as he will of the war."

Dartford Destructor.

Dartford has now the benefit of an up-to-date refuse destructor plant by Messrs. Meldrum Bros., Ltd. The buildings which are of a very substantial character are placed next to the electric light works and sewage pumping station in Priory Road.

The destructor furnace is a two grate regenerate top feed type Meldrum "Simplex" refuse destructor, guaranteed to destroy 30 tons of ordinary house refuse per day of twenty-four hours. Its accessories include a Lancashire boiler, 30 ft. long by 8 ft. diameter; Sugden superheater, regenerator for heating the air to consume the refuse, Green's economiser, Hall's pump, Lassen and Hjort's water softener, Mather and Platt's water filter, etc., and are such as to ensure the whole of the available power being economically utilised, without sacrificing or impairing the completeness of destruction, which is the primary object of the plant.

Junior Engineering Society.

At a meeting of this Society, Mr. W. H. Pearce (member) read an instructive paper on "Valves and Valve Diagrams." A discussion by Messrs. G. H. Burrows (chairman), Bayley, Roberts and Deverell followed, the author being heartily thanked for his paper.

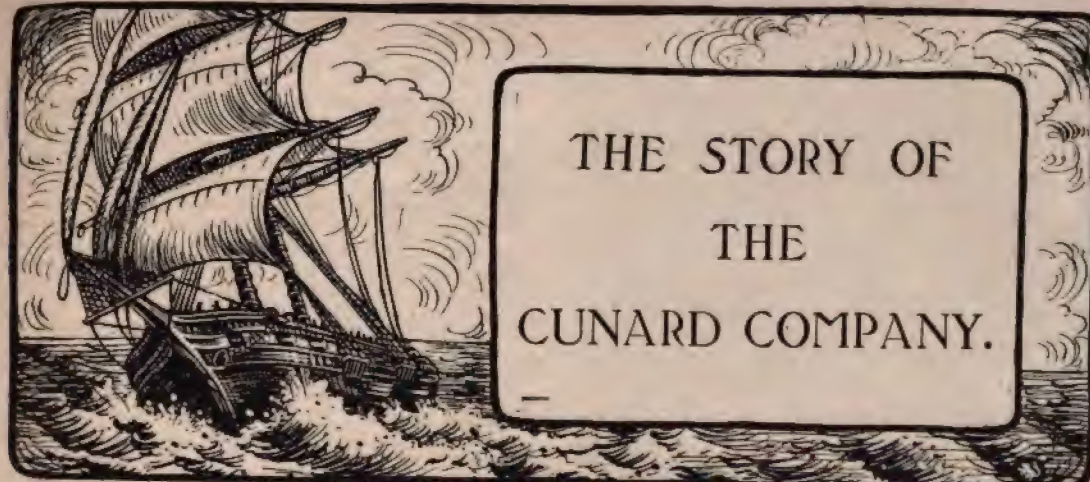
At the second intermediate meeting of the Junior Engineering Society the subject brought forward for discussion was the Great Western Company's engines "Albion" (simple), "La France" (compound). The engines were described by Mr. G. Burrows, whose remarks were followed by an interesting discussion, in the course of which Mr. J. W. Smith (Chief Draughtsman of the Midland Railway) stated he had had considerable experience both on the North-Eastern and Midland Railways with compound engines. The Midland people, after exhaustive experiments, had come to the conclusion that three-cylinder compound engines were the best. In his opinion, there was no doubt that compounding was the most economical method of working, and as regards repairs, one of the Midland compounds had now been running for two years without going into the shops.

Ventilation of the House of Commons.

In spite of the many attempts made to improve the ventilation of the Houses of Parliament, it is undoubtedly a fact that Members have experienced very depressing effects therein—effects which it is supposed have not on all occasions been due to the languor of debate. However this may be, it has now been decided to thoroughly overhaul the arrangements, and to install new ventilating plant.

Messrs. Matthews and Yates, Ltd., of Swinton, Manchester, also of London, Leeds, Glasgow, etc., have been entrusted with the order for this plant, and it is hoped by the commencement of another session to have it installed. Experiments already made give the assurance that such an improvement will be effected throughout, that members will have no further cause for complaint.

During the past two years or so, Messrs. Matthews and Yates have supplied some sixty or seventy fans for the ventilation of committee rooms, division lobbies, lavatories, etc., and it is doubtless due to the satisfactory working of these fans, and the results obtained therefrom, that they have now been entrusted with the larger work of ventilating the "House" itself.



THE STORY OF THE CUNARD COMPANY.

BY

BENJAMIN TAYLOR, F.R.G.S.

The history of the Cunard Company is, no doubt, to many people somewhat of an oft-told tale. While the Cunard Company have been undoubtedly fortunate, an examination of their history and methods will show that their luck has been deserved. No precaution which human foresight or the keenest business ability could devise has ever been forgotten or omitted.—ED.

THE Cunard service was started just two years after the practicability of steam navigation on the Atlantic was demonstrated by the voyage of the *Sirius* from London to New York. She made the voyage in seventeen days, and was followed by the *Great Western*, which did it in fifteen days. Other vessels still further proved the practicability of doing what Dr. Dionysius Lardner had declared to be as impossible as a voyage to the moon—or something to that effect, but Dr. Lardner is not always correctly quoted. According to Mr. Hodder, the biographer of George Burns, one of the founders of the firm of G. and J. Burns, a matter so important did not escape the attention of Burns, to whom Sir Edward Parry, then Comptroller of Steam Machinery and Packet Service at the Admiralty, sent an intimation that the Government were about to invite tenders for a mail service between England and America. The idea of a steam service was by this time a common enough one, and was not (as is sometimes alleged) the invention of either Samuel Cunard or George Burns. The days of the "coffin brigs" were numbered, and the Admiralty advertisement for steamers was spread broadcast before Samuel Cunard appeared on the scene. George Burns thought carefully over the matter, but did not see his way to risk or lose the coasting trade, which he had built up, by embarking on so large an undertaking as an Atlantic service. His hands were full, or he thought they were. And then came the inspiring genius. "Away in Halifax, Nova Scotia, dwelt Samuel Cunard, a member of a well-to-do Quaker family, which emigrated from Wales to America early in the seventeenth century, and settled at Philadelphia. The family, being Royalists, left the United States for Halifax, and here in 1788 Samuel Cunard was born. After serving some time in a merchant's office, he so much distinguished himself that he was offered a partnership with one of the leading firms of shipowners in Boston. Here he found scope for his great energy and ability, and entered into various enterprises, engaging with newly built vessels in the West Indian trade and in the South Sea whale fishery. In 1815, while still a young man, under thirty, he proposed to the Admiralty to undertake at his own risk the conveyance of mails between Boston, Newfoundland, and Bermuda, and carried out his scheme so satisfactorily as to earn the thanks of the British Government."

CUNARD'S IDEALS.

Thus Cunard was a shipowner, experienced in mail-carrying work, and favourably known to the British Government, before ever the Atlantic service was proposed. He paid close attention, however, to the experiments in steam navigation that were being made, and as early as 1830 began to dream dreams of ocean railways. It was his belief that steamers over a route of thousands of miles might start and arrive at their destinations with a punctuality like that of railway trains, if the ships were thoroughly well built and well manned, and their course laid down with accuracy. The steamship, he thought, was to be the ocean railway train *minus* the longitudinal pair of metal rails. The rails, Samuel Cunard used to observe, were needed only on the "ugly, uneven land," with its high hills and deep valleys, but the level sea did not need them.

HIS OPPORTUNITY.

It was one of the Admiralty circulars of 1838 (or 1839), which George Burns had considered and laid

LORD INVERCLYED.
Chairman of the Cunard Company.

aside, that first brought Cunard within sight of his opportunity. He knew what he wanted to do, but he had not enough capital to do it, and he could not persuade the merchants of Halifax to join him in the enterprise. Therefore, he went to London, and he obtained there a letter of introduction to Robert Napier, the famous engineer and shipbuilder in Glasgow, of whom we must present a note :—

"Robert Napier was a man worth knowing. He started life as an apprentice to his father, who was a blacksmith. At the age of twenty-four he received from his father the sum of £50—£45 of which he spent in the purchase of tools and the goodwill of a small blacksmith's shop in the Gallowgate, Glasgow, leaving £5 for working capital. By rapid steps his business developed; iron-founding and engineering were first added to it; then the building of marine engines; then the building of first-class steamers of all sizes for the mercantile marine, and for war purposes for various foreign countries as well as our own. His premises grew from the tiny shop in the Gallowgate to larger ones in Washington Street, engineering works in Lancefield, and the famous shipbuilding yard in Govan; and his staff, which at first consisted of only two apprentices, increased until upwards of three thousand persons were in his employ."

To this wonderful man, this father of marine engineering, went the prophet from Halifax. Napier knew Burns well, for he had engined the steamers of the Glasgow and Liverpool Line, with which G. and J. Burns had amalgamated. But he went first to James Donaldson, a wealthy cotton broker, and the moneyed man in a former opposition line of Liverpool steamers that Burns had won over. And this is what happened, as related by George Burns himself :—

INCEPTION OF THE SCHEME.

"It was arranged that when Cunard went to Mr. Napier, he was to take him to Donaldson, who on his part was to bring him to me. Donaldson came trotting down from his office, and told me Cunard and Napier were waiting for me, and had proposed that we should do something to get up a concern for carrying the North American mails. Donaldson said to me, 'I told Mr. Cunard that I never did anything without consulting a little friend of mine (meaning myself), and if he pleased I would bring him down to your office.' So down Donaldson came with Cunard, introduced him, and left him alone with me to talk it over. It was not long before we began to see some daylight through the scheme, and I entertained the proposal cordially. That day I asked Cunard to dine with me, and also David MacIver, who was at that time residing in Glasgow as agent for the City of Glasgow Steam Packet Company. I propounded the matter to MacIver, but he did not seem to see his way clear; on the contrary, he went dead against the proposal, and advised that after dinner I had better tell Cunard that the thing would not suit us. As talking after dinner generally ends in nothing, so it did on this occasion. However, Mr. Cunard asked us to come down and take breakfast with him and Mr. Robert Napier in Mr. Napier's house. We went accordingly, and after going into details I told Mr. Cunard we could hardly take up such a large concern as the proposal before us would amount to, without inviting a few friends to join us; and that as it would not be fair to keep him in suspense, we would set him free to make any arrangements he thought best with his own friends. He replied, 'How long will it take to ascertain what you can do?' I answered, 'Perhaps a month'; and he said, 'Very well, then, I'll wait.' That same day I set out and spoke first of all to Mr. William Connal, then at the head of a large firm engaged in the commission trade of produce and other things. Mr. Connal said to me, 'I know nothing whatever about steam navigation, but if *you* think well of it I'll join you.'"

The subscription was £5,000 each, and within a few days George Burns got together the whole capital of £270,000 required. Then, in due time, the tender was submitted to the Government for a fortnightly mail between Liverpool, Halifax and Boston. The tender was accepted over that of the owners of the *Great Western*, and the contract was signed by Samuel Cunard, George Burns and David MacIver.

But this is not the whole story of the origin. The following is taken from a letter written in 1895 by John Napier, son of Robert Napier, narrating the story as told to him by his own father :—

"The Hon. Samuel Cunard, being in London in the latter end of 1838, consulted his friend Mr. James Melvill, secretary of the old East India Company, as to vessels he required to carry out a contract he had for conveying the mails between England and America. Melvill recommended him to communicate with my father, and this he (Cunard) did on February 25th, 1839, through his correspondents in Glasgow, Messrs. William Kidston and Sons, whom he asked to get an estimate from my father for 'one or two steamboats of 300 h.p. and about 800 tons. In reply to this inquiry my father, on February 28th, 1839, wrote Kidstons, making offer to supply Mr. Cunard with the vessels he asked for. A few days after that Cunard came to Glasgow and saw my father, and explained to him fully his requirements, with the result that he accepted an offer from my father to build three vessels of 800 tons and 300 h.p. for the sum

of £30,000 each. On, however, thinking more over the matter and the nature of the trade the vessels were to be employed in, my father became convinced that they were too small, and urged Cunard to make them larger, which in the end he agreed to do, and on March 18th, 1839 (the offer and acceptance of the small vessels being cancelled), a detailed and stamped contract in duplicate was signed at Glasgow by 'S. Cunard' and 'R. Napier.' The vessels were now to be each 200 ft. long, 32 ft. broad, and 21½ ft. depth of hold, with engines having 70 in. cylinders and 6½-ft. stroke, all finished complete in cabins, etc. (similar to vessels my father had lately built for the City of Glasgow Company), and the price for each of the three vessels was to be £32,000.

"On March 21st, writing from London to my father, Cunard, amongst other things, mentions that he had been to the Admiralty and Treasury, who, he says, 'are highly pleased with the size of the boats.' My father, however, was not yet pleased with the size. He still thought them rather small for such a long voyage, and felt that larger vessels would be more economical, and he said so to Cunard, who, however, stuck to the size as had been fixed. He (Cunard), however, when again seeing his friend Melvill in London, and telling him about the contract he had made, told him also that my father still thought the vessels rather small, and that were they larger they would in the end be more economical, and he (Cunard) at the same time told Melvill that, were it not for the expense, he would go in for rather more size, but that unless he could get up a company, which up till now he had failed in doing, he could not build larger vessels.

"On hearing that, and thinking over it, Melvill advised Cunard to go at once back to Glasgow and lay his difficulties unreservedly before my father, as very likely he and his friends could help him, even in the formation of a small company, and so allow of more suitable sized vessels being built. Cunard took Melvill's advice, and returned to Glasgow and stated his difficulties to my father, who, after considering the matter, thought he saw his way to help. Now, shortly before the time of which I am now speaking, there were two powerful companies running in tooth-and-nail opposition to each other between Glasgow and Liverpool. The one was managed by Messrs. Martin and Burns, and the other by Messrs. Thomson and McConnell. My father was a shareholder of the latter company, and engined their vessels. At the beginning of 1839, however, these two opposing companies (having come to an understanding with each other) were working together harmoniously, and my father, thinking it might bind them more closely were he to get their principal shareholders to take an interest in Cunard's undertaking, saw first his friend James Donaldson, and one or two other shareholders of the Glasgow and Liverpool Company he (my father) was connected with, and then he called on George Burns (of Martin and Burns, the agents of the other Glasgow and Liverpool company), with Donaldson and Cunard, and introduced the latter to Burns, who, after hearing Cunard's views, and seeing the possibilities of his mail scheme, got his friends to join with Donaldson and my father's friends (in all about 30), and to subscribe the needed amount of capital towards the proposed company—the company now known as the 'Cunard Company.'"

The reason why Samuel Cunard went to Melvill was that Cunard was agent in Halifax for the East India Company, of which Melvill was secretary, and the reason why Melvill recommended Robert Napier to supply the steamers was that in 1836 Napier had engined the steamer *Berenice* for the East India Company. This was the first ocean-going steamer he engined, and she was so successful that a great friendship sprang up between Napier and Melvill. The *Berenice* made the voyage to India, *via* the Cape of Good Hope, at the rate of eight knots an hour, with a consumption of eight tons of coal per day.

GEORGE BURNS.

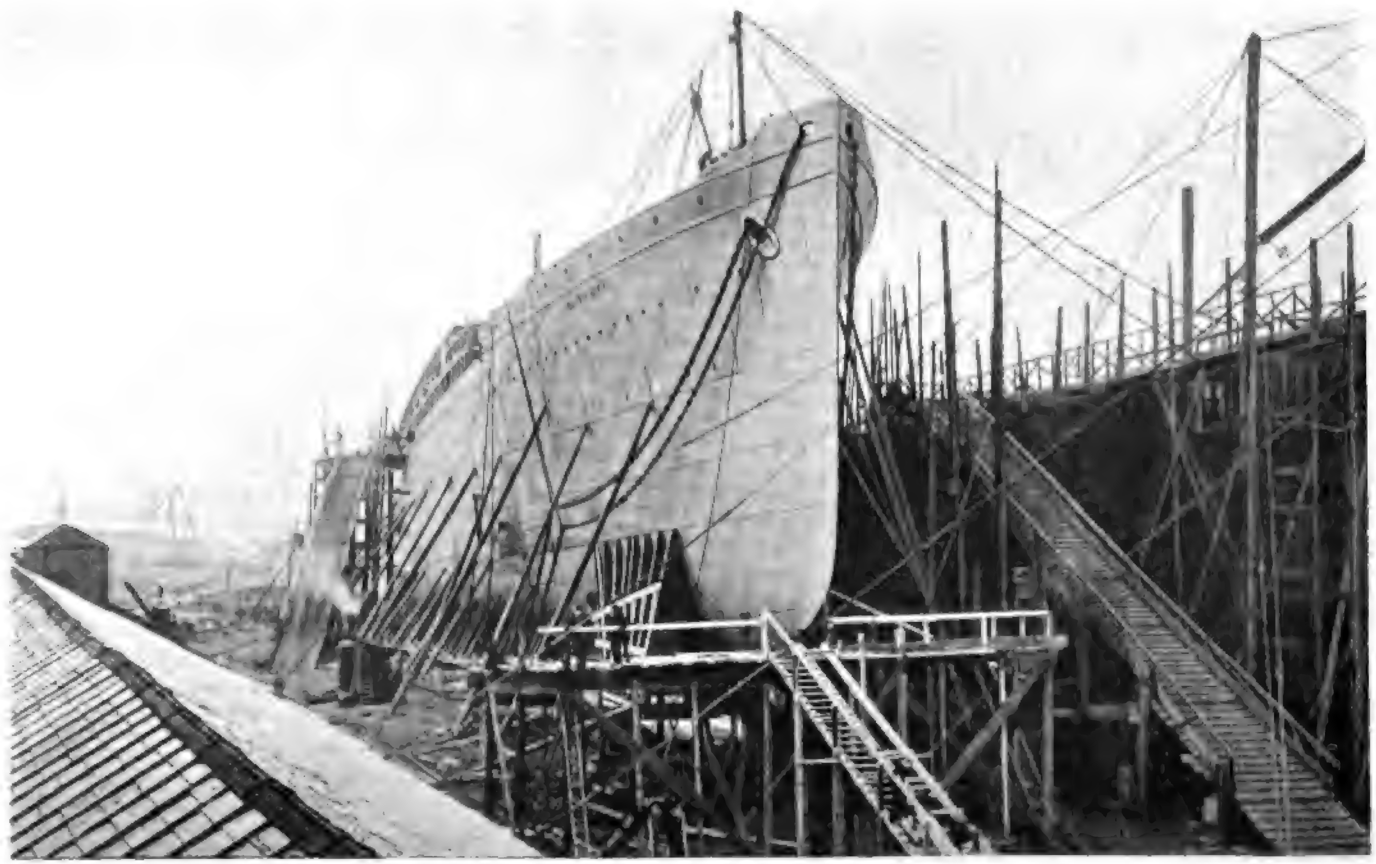
George (afterwards Sir George) Burns was born in 1795, and the initiation of the new fast service will probably mark his 110th year. He was the son of the minister of the Barony Parish, Glasgow, and after preparatory work in the office of the Cotton Spinning Company, originated by the famous David Dale (and afterwards carried on by Robert Owen, the Socialist), began business in 1818 in partnership with his brother James. As "sons of the manse" they were favourably regarded, and being honourable, shrewd, persevering, far-sighted and enterprising, though cautious, they soon made a name and position for themselves. They started as "general merchants," but chiefly in grain and produce. George did the travelling, and James attended to the counting-house. In 1824 they secured the agency for Matthie and Theakstone's line of Liverpool and Glasgow sailing smacks. This was their beginning with shipping, and as it developed George devoted himself entirely to this branch of the business, leaving the produce department to the management of James. And the produce business, under the firm-name of J. and G. Burns, was carried on until the death of James, while the shipping business was carried on in separate premises, under the firm-name of G. and J. Burns. Soon after securing the smack agency, the Burnses purchased a share in the smacks, and shortly after that they received the agency for a line of steamers which some people in Belfast had decided to establish between that city and Glasgow. George Burns' connection with steam began in 1824, and by the time Cunard appeared, in 1838, G. and J. Burns had lines of steamers of their own running from Glasgow to Liverpool, to Belfast, to Ayr, and to the West Highlands—the last-named being the line now carried on by David MacBrayne and Sons.

THE FIRST CUNARDERS.

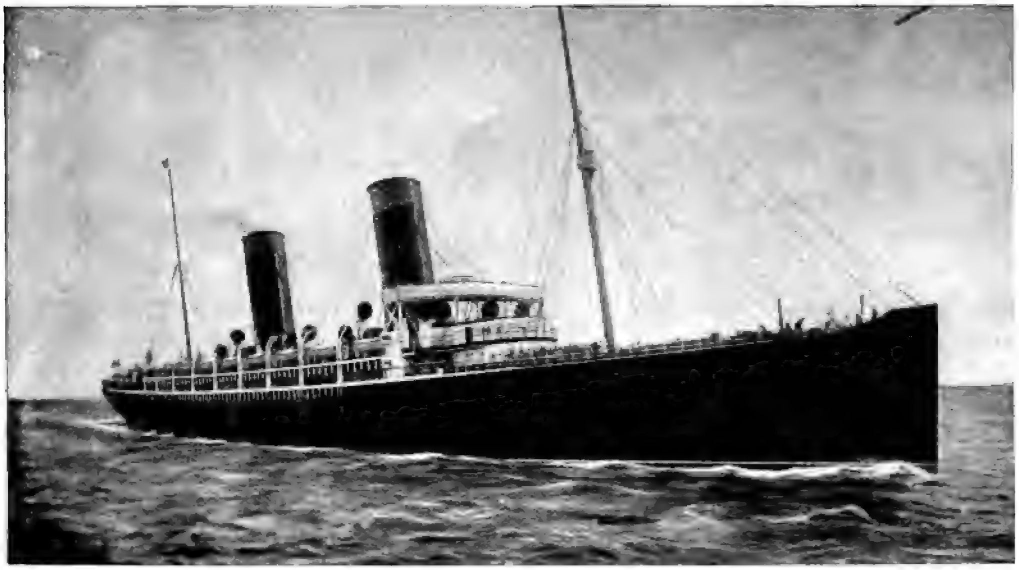
The company formed with Cunard was "The British and North American Royal Mail Steam Packet Company," with a capital of £270,000, the bulk of which was provided by George Burns and David MacIver. The dimensions of the first Cunarders were :—

Vessels.			*Tons.*	*Length.*
Britannia	..	..	1,156	207 ft.
Columbia	..	..	1,138	207 ft.
Acadia ..	..	..	1,136	206 ft.
Caledonia	..	..	1,138	206 ft.

They were all wooden paddle boats, and their speed at sea was about 8½ knots. The tender of the Cunard Company for a fortnightly mail service from Liverpool to the United States was at an annual subsidy of £55,000. The sailings were afterwards made weekly, and the subsidy increased to £81,000 a year. The first vessel, the *Britannia*, sailed on her maiden voyage on July 4th, 1840, so that the line is now sixty-three years old. The next ships built were the *Cambria* and *Hibernia*, of 1,422 tons and 9½ knots speed, and by 1848 the company had built four more vessels—named *America*, *Niagara*, *Canada*, and *Europa*—all paddle steamers of 1,825 tons and 10½ knots.



THE STEAMSHIP "CAMPANIA" ON THE WAYS.



THE CUNARD STEAMSHIP "LUCANIA."

The original subscription list was as follows :—

	Shares.	
James Donaldson, cotton broker ..	160	£16,000
James Browne, insurance broker ..	116	11,600
James Wright, cotton broker ..	116	11,600
Thomas Buchanan, merchant ..	116	11,600
James Campbell (of J. and W. Campbell), warehouseman ..	60	6,000
Robert Hinshaw, drysalter ..	119	11,900
Alex. Downie, of Downie and Maclure	55	5,500
Wm. Brown, of Kilmardinny ..	116	£11,600
Robert Napier, shipbuilder ..	60	6,000
Robert Rodger merchant ..	116	11,600
Wm. Campbell (of J. and W. Campbell), warehouseman ..	55	5,500
Wm. Leckie Ewing, of Arngomery	116	11,600
Arch. McConnell, of Thomson and McConnell	20	2,000
Wm. Connal, West India merchant	116	11,600
George Burns, of G. and J. Burns..	55	5,500

DRAWING-ROOM ON BOARD THE "LUCANIA."

THE CUNARD COMPANY'S PIERS AT NEW YORK.

	Shares.	
James Burns, of G. and J. Burns ..	55	£5,500
David MacIver, of Burns and MacIver	40	4,000
Charles MacIver, of Burns and MacIver	40	4,000
Alex. Fletcher, calico printer ..	116	11,600
Alex. McAslan, of Austin and McAslan	105	10,500
Alex. McAslan, of Austin and McAslan	3	300
Wm. Stirling, of Stirling, Gordon and Co.	116	11,600
Elias Gibb, wine merchant ..	64	6,400
Jas. Merry, of Merry and Cunninghame	37	3,700
David Chapman, of Thomson and McConnell	15	1,500
Alex. Glasgow, of Auchenraith ..	64	6,400
Alex. Bannerman, Manchester ..	21	2,100
John Bannerman, Manchester ..	21	2,100
Henry Bannerman, Manchester ..	21	2,100
James Martin, of G. and J. Burns ..	16	1,600
David Scott	16	1,600
James McCall, of Daldowie ..	13	1,300
Alex. Kerr, of Robertland ..	7	700
Samuel Cunard, Halifax, N.S. ..	550	55,000

(Stock of 2,700 shares and £270,000, 1839.)

THE ORIGINAL SUBSCRIBERS.

With the exception of Samuel Cunard, a Nova Scotian, all the subscribers were Glasgow men. The MacIvers (the Liverpool partners of the Burnses) were resident in Liverpool, and the Bannermans in Manchester, the latter being brought into the concern through their brother-in-law, James Campbell, of J. and W. Campbell and Co., Glasgow. The Campbell-Bannerman family interest was the largest (£17,800). Mr Leckie Ewing was a family connection of the Campbells. George Burns, the real founder of the company, was the last survivor of the original partners' and died in 1890, aged ninety-four. Samuel Cunard, the nominal founder, brought in £55,000, but George Burns, the life and soul of the promotion, found all the rest of the capital. At first his partners—the MacIvers, Martin, and his own brother, who was his senior—held back, but his perseverance succeeded in carrying them all along with him. Sons of some of the original subscribers are alive, such as, notably, Mr. James A. Campbell, M.P. for Glasgow University, and Sir Henry Campbell-Bannerman, M.P., both sons of Sir James Campbell; while sons of Mr. Leckie Ewing and Mr. Browne survive in Mr. Robert Leckie Ewing, of Arngomery, and Mr. R. B. Browne, of Bendarroch, Dumbartonshire, formerly of Browne, Easton and Co., of the Glasgow Underwriters' Rooms and Lloyds.

INTRODUCTION OF IRON SHIPS.

For twenty years the vessels of the Cunard line were built of wood, the transition to iron being delayed by the refusal of the Government to allow the mails to be carried in iron ships. But in 1860 this restriction was withdrawn, and the *Persia*, an iron paddle steamer of 3,766 tons was built. Her length was 350 ft. and her h.p. 3,600. The *Scotia*, which for some time held the record of eight days twenty-two hours from New York to Liverpool, was the last of the big paddle boats constructed for the Cunard. She was built in 1862, and was of 3,871 tons, 4,200 h.p., and 367 ft. length. She was later converted into a twin-screw vessel, and did service as a cable steamer. The *China*, launched in 1862, was the first Cunard screw steamer. In 1867 came the *Russia*, of 2,960 tons and 3,000 h.p., which averaged more than 14 knots, and reduced the record from New York to Queenstown to just over eight days. Subsequent crack Cunarders were the *Batavia*, 2,553 tons; *Calabria*, *Algeria*, and *Abyssinia*, each of 3,300 tons; *Scynthia* and *Bothnia*, 4,535 tons; and *Gallia*, 4,808 tons. Steel next began to replace iron as the material for shipbuilding, and in 1881 the *Servia*, of 8,500 tons and 530 ft. long, was launched on the Clyde. In January, 1882, she broke the record with a passage from New York to Liverpool in seven days eight hours fifteen minutes, but a few months later the Guion liner, *Alaska*, ran from New York to Queenstown in six days twenty-two hours. In 1888 the Cunarder *Etruria* did the westward passage in six days one hour forty-seven minutes.

MODERN CUNARDERS.

The history of the Cunard Company had been closely bound up with the struggle for the "blue ribbon" of the Atlantic. The *Servia* was 540 ft. in length, and was the longest ship that had then (1882) been built, though she was soon eclipsed in this respect by the Anchor liner *City of Rome*. The *Servia's* sea speed was 17½ knots. In 1884, however, the *Umbria* and *Etruria* were launched. These were sister ships, each of 8,127 tons, and 501 ft. in length, with an indicated h.p. of 14,500. The fastest time of these vessels was done by the *Umbria* on her eighty-second trip, when she ran from Queenstown to New York in five days twenty-two hours, an average speed of 19·57 knots. In 1891 the most modern of the big Cunarders were ordered. These were twin-screw boats, the *Campania* and *Lucania*, the largest vessels (except the *Great Eastern*) ever built up to that period. They were launched by the Fairfield Shipbuilding Company in September, 1892, and February, 1893. The dimensions of these vessels are:—

Gross tonnage	12,950
Net tonnage	4,975
Length over all	620 ft.
Length between perpendiculars	601 ft.
Beam	65 ft. 3 in.
Depth from upper deck	43 ft.
Indicated h.p.	30,000

Of the two the *Lucania* is slightly the faster. Their usual sea speed is from 21½ to 22 knots per hour, and their record voyages are:—

	Outward.			Homeward.		
	Days.	hrs.	mins.	Days.	hrs.	mins.
Lucania ..	5	7	23	5	8	38
Campania	5	9	6	5	9	18

The Cunard Line boast that not a single passenger ever lost his life through a mishap to one of their vessels. The worst loss the Cunard Company ever sustained was that of the *Oregon*, a fine new steamer which, on March 14th, 1886, was sunk by collision with an unknown schooner near Long Island, but all those on board were safely transferred to the boats, and not a life was lost. The *Pavonia* once drifted about for days in a gale with her boilers loose, but was towed to harbour, and the *Etruria* in 1902 lost her propeller, and yet was taken into port without further damage. The Cunard Company have of late years adopted the policy of building large first-class twin-screw intermediate steamers of great cargo capacity, fair sea speed, and with accommodation for a limited number of passengers, such as the *Saxonia* and *Ivernia*.

(To be continued.)

Specially taken for "PAGE'S MAGAZINE."] PROFESSOR PERRY AT WORK IN HIS STUDY. [Elliott and Fry.

OUR MONTHLY BIOGRAPHY.

PROFESSOR JOHN PERRY, M.E., D.Sc., LL.D., F.R.S.,

Whit. Schol., Assoc.M.Inst.C.E., Professor of Mechanics and Mathematics at the Royal College of Science.

PROFESSOR PERRY was born in Garvagh, County Derry, in 1850, and spent the early years of his life in that secluded market town, where it was the fashion to think and act for oneself. There there can be no question but that this circumstance, combined with healthy outdoor life, had a marked influence upon his mental training.

Professor Perry comes of a literary stock. All the family, it seems, wrote verses except himself, and it is not surprising to hear that in such an environment he was fond of Scott and Cooper at nine, and enjoyed Shakespeare at twelve years of age. At the present time he is an omniverous reader of general literature, with a special penchant for historical works, and in this connection it is interesting to note that, although a French and German scholar, he prefers to use even the worst published English translation of a foreign book rather than read the original.

At the Model School at Belfast he carried off numerous prizes, and secured a silver medal in natural science, and on matriculating at Queen's College, Belfast, he obtained a science scholarship and the Peel prize in geometry. A series of additional prizes and exhibitions, including Whitworth Exhibitions in 1868 and 1869 and a Whitworth scholarship in 1870, culminated in the latter year when he graduated as Bachelor of Engineering in the Queen's University of Ireland with first class honours, a gold medal and the Peel prize.

His earliest practical training was gained during an apprenticeship to Messrs. Coates, of the Lagan and Prince's Dock Foundries, Belfast. He is of the opinion that for a student to know great men is a very important factor in his education; his professors were nearly all well-known men—Purser, Thomas Andrews, James Thomson (brother of Lord Kelvin), Wyville Thomson, and others.

Professor Perry was lecturer in physics at Clifton College 1870-74, and there started the first School Physical Laboratory and Workshop, which are still thriving institutions. In 1874 he acted as secretary to the A section of the British Association, and in the same year became Thomson scholar and honorary assistant to Sir William Thomson (now Lord Kelvin) in Glasgow.

In 1875 Dr. Perry went to Japan as joint professor (with the principal) of engineering in the Imperial College of Engineering, and returned to England in 1879. Professor Perry says that in patriotism, in courage, in character, in all that goes to make what we call *soul*, the Japanese people are ahead of all other nations. In conjunction with Professor Ayrton, he did so much electrical work that Professor Clerk Maxwell jocularly remarked that the electrical centre of gravity had removed to Japan.

His activities since his return from Japan have been manifold. His first task was to organise the works of Messrs. Clark and Muirhead, introducing large tools, machinery for the covering of wire with gutta percha, etc., and for the testing of dynamos.

Professors Ayrton and Perry were appointed joint engineers to the Faure Accumulator Company a few months after it began work, and remained in that capacity until the English patents were disposed of. They lighted, among other places (in 1883), the Grand Hotel, Charing Cross; arranged the driving of tram-cars and tricycles and experimented on accumulators at the manufactories in Liverpool and Paris. The only motors which gained prizes at Paris in 1889 were of their invention. They invented multipolar dynamos in 1882, and their other joint inventions are numerous. On the death of Professor Fleeming Jenkin, Dr. Perry became engineer of the Telpherage Company, and from July to October, 1885, superintended the erection and setting to work of the telpher line at Glynde, in Sussex.

In 1882 he became Professor of Mechanical Engineering and Applied Mathematics at the Finsbury Technical College, and in 1896 he became Professor of Mechanics and Mathematics in the Royal College of Science, London.

Of the lectures to students, and the papers which he has contributed to the technical societies, we can only mention a selection. He wrote many of the mathematical and physical articles in Blackie's "Cyclopaedia," and published an Elementary Treatise on Steam, issued by Macmillan in 1873; his book on Practical Mechanics is well known. Other works include "The Calculus for Engineers," and "Steam, Gas, and Oil Engines." His first scientific paper was read before the Royal Society of London early in 1875, on "The Electric Conductivity of Glass as Dependent on Temperature." In partnership with Sir William Thomson, he read a paper on "Capillary Surfaces of Revolution" in 1875 before the Royal Society of Edinburgh. The Society of Arts in 1881 awarded him their silver medal for a lecture on "The Future Development of Electrical Appliances." In 1882 he delivered a course of Cantor Lectures on hydraulic machinery. At the Leeds meeting of the British Association he delivered the Operatives' Lecture on "Spinning Tops" (this is now published as a small book by the S.P.C.K., and is also being published in German).

Professor Perry arranged the system of technological examination in mechanical engineering of the City and Guilds' Institute. As a chairman of the examiners in the seven engineering subjects of the Science and Art Department, he has now more influence over methods of teaching in science classes. The publication of his lectures on "Practical Mathematics to Artizans" (Spottiswoode, 1899, and just translated into German) first acquainted the public with the value of some of his evening courses at Finsbury twenty years ago; the method is now being adopted in Germany and America. A result of the B.A. discussion in 1901 (published by Macmillan) is that a reform has already begun in the teaching of mathematics, and great changes have already taken place in the Oxford and Cambridge local examinations, as well as those of the Civil Service Commissioners. Young boys are now doing experimental mathematics, using squared paper, and the language of the infinitesimal calculus; and the subject of practical mathematics is being taught to hundreds of thousands of students. His addresses as President of the Institution of Electrical Engineers (1900-1), and as President of Section G of the British Association (1902), his inaugural address at the Royal College of Science (1902), his address at Oxford (published in "Nature," December 31st, 1903), and many other addresses, memoirs and letters, have given rise to discussions on education. Professor Perry has unquestionably considerable originality of ideas in educational matters, and has always been fortunate in choosing the psychological moment for acting upon them.

A NEW 4-TON STEAM-HAMMER.

THIS steam hammer, nominally 4 tons, is of the "Girder" type, that is, the cylinder is carried on a girder supported at each end by a column. The girder is built up of steel plates and angle bars, and the columns are of cast iron.

In forging large masses of iron or steel, it is, of course, a great advantage to the forgemen to have plenty of room all round the hot forging wherein to carry on their work, and in designing the hammer, Messrs. Davis and Primrose, of Leith, have afforded convenience for this in a marked degree, the space between the columns being 17 ft., with a clear height of 11 ft. to lowest flange of girder.

The cylinder is 26½ in. diameter of bore, or, say, 552 square inches of area, and the permissible length of stroke, 66 in. There being 80 lb. per square inch of steam pressure on the top of this piston, a force of 20 tons is exerted in a downward direction, and the weight of the piston-rod itself, being 4 tons, the falling weight may be stated as 24 tons.

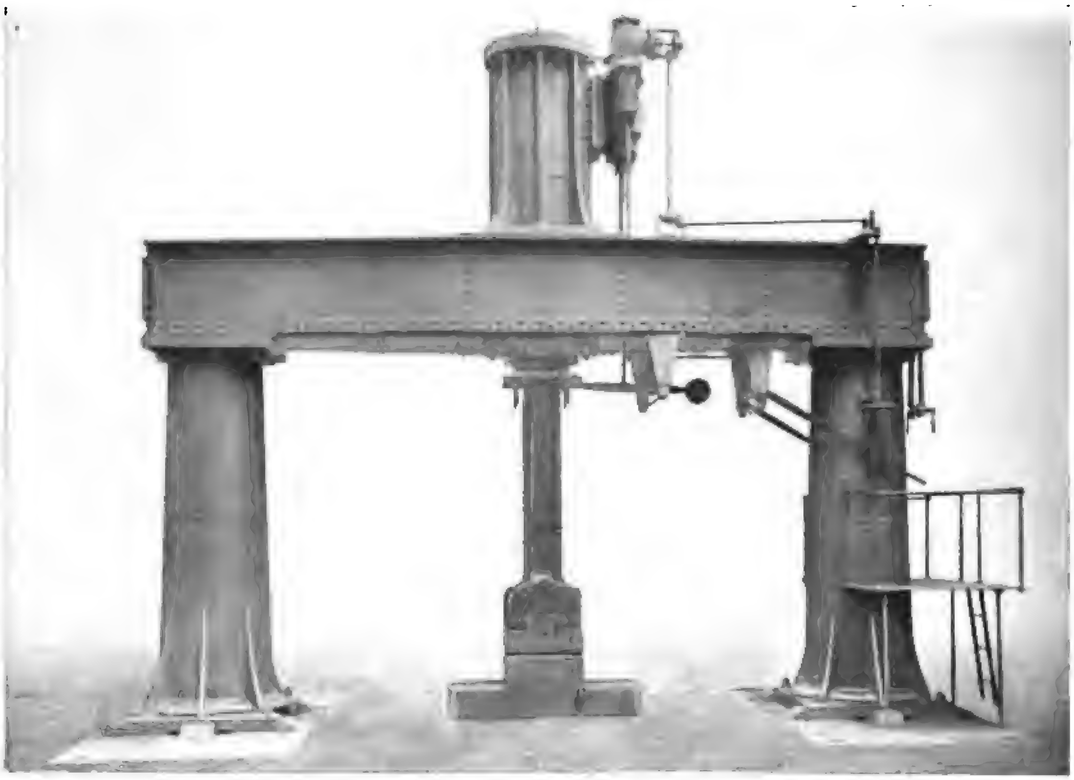
The driver stands on the small elevated platform seen on the right, from which position he has a clear view of the forgeman, who gives him his orders, also of the forging that he may be going to strike with the hammer. There are double handles, so that the driver can work the hammer from either side of the column.

The columns are each bolted to a base-plate, the two base-plates are kept in position by strong ties and struts, also bedded into ground, and concrete.

The anvil block is a casting of 32 tons weight, having a base 7 feet square resting on timbers and concrete. The anvil is held in the block by dovetail and key.

For guiding the piston-rod there are two flats planed on it, and the lower part of the cylinder has a long stuffing box of a special design of the makers, which, with the massive steel Gland, forms a capital guide.

The complete equipment embraces two forge cranes, each capable of carrying 20 tons, two heating furnaces, and the necessary boilers for raising steam.



NEW 4-TON STEAM HAMMER BY MESSRS. DAVIS AND PRIMROSE, LEITH.

VANCOUVER HARBOUR.

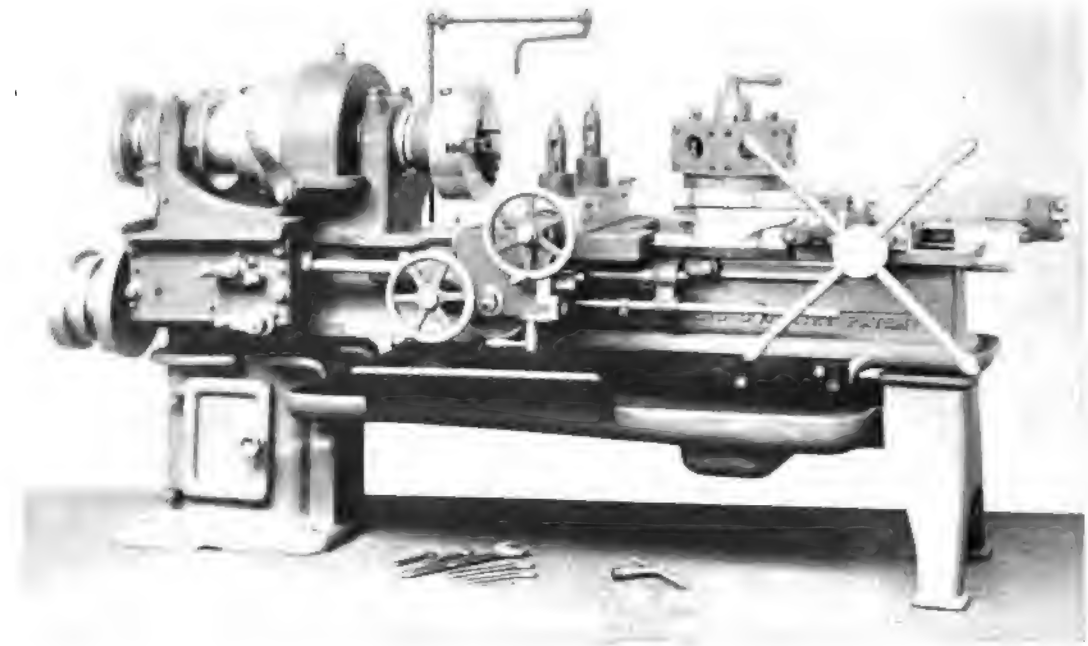
Mining in British Columbia and the Klondyke.

IN Mr. A. G. Bradley's new book on Canada in the Twentieth Century,* there is an interesting reference to the mining possibilities of British Columbia, a number of pages being devoted to Vancouver, which is not only an outfitting centre for the mining regions in the interior, but also for the great Klondyke and Yukon district of the far north.

"A number of people in Vancouver are interested in mines, and may be described just now as 'staying with their investments,' occupying themselves in the meantime with more active concerns. The auriferous regions of British Columbia are immense, so are the coal, iron, copper, and silver-lead depôts. In spite of the busy districts and mining centres such as Nelson, Rossland and Greenwood, they are as yet but faintly known and scarcely trenched upon, but everyone is aware that gold mining has been, and is, a brisk industry in the province, and that the latter has a market of its own, and has had its boom. The memory of this rankles in the minds of most British Columbians, and still more in that of others who are not residents of the Pacific province. There is no question whatever of the potentialities of the country, but confidence in it abroad was temporarily shaken, if not shattered, by the unwisdom of its immediate friends and exploiters. Men lost their heads, and for the most part their money, in reckless speculations, and the market acquired such a reputation for wild-cat schemes that the outside investor was ultimately choked off, and buttoned up his pocket relentlessly against all further propositions from British Columbia. Thus was a good thing spoilt by the short-sighted folly of those who had its making in their hands—spoilt for the time that is to say. The paying mines do not cease to pay on account of paper speculations among the mountains surrounding them, and no doubt confidence will one day be restored to a field that itself has given no cause whatever to forfeit it. One hears a great deal of the Yukon in Vancouver—that far away mysterious mining region generically known in England as Klondyke. One meets many people from there wintering in Vancouver, who are glad enough to exchange the temperature of 45 deg. and even 60 deg. below zero for a winter like Bournemouth or Ilfracombe. Steamers run from Vancouver for a thousand miles through countless islands to Skagway in Alaska, and thence passengers for the Yukon proceed by rail over the famous 'White Pass' to Dawson City, six hundred miles away and in British territory. The terrors of the old route to Klondyke, the dangers by land and water, by frost, hunger and mysterious diseases, were in the later nineties of world-wide notoriety, and were in no wit exaggerated. I have been much in company with many people on the coast who went through them all, and have heard tales enough of their adventures to fill a book. But now they go backwards and forwards by rail and steamer in luxury, though at great expense, while Dawson has every convenience of an ordinary North American city—though at twice or three times the cost."

Although designed chiefly for the general reader and largely devoted to agriculture, Mr. Bradley's work will be useful to any young engineers who have fixed upon Canada as their objective, owing to the fact that it is based upon the very latest conditions of Canadian life. There are numerous plates, which include the accompanying view of Vancouver Harbour.

* "Canada in the Twentieth Century," by A. G. Bradley. 16s. net. Published by Archibald Constable and Co., Ltd.



NEW LATHE BY MESSRS. ALFRED HERBERT, LTD.

A NEW ACCESSORY FOR MOTOR MANUFACTURERS.

THIS is a machine which has been recently developed by Messrs. Alfred Herbert, Ltd., mainly for dealing with medium size chuck work, and has been very largely supplied to manufacturers of motor cars for making parts from bars too large to go through the spindles of the ordinary turret lathes.

The machine in question has 9-in. centres and has 3¼-in. hole through the spindle, thus enabling bars of considerable size and weight to be handled.

The hexagon capstan is a feature of great utility when the lathe is used on large bars, as it enables special tools of considerable size to be firmly attached to its faces. In the case of an ordinary capstan lathe there is difficulty in using a tool beyond a certain size and weight on account of the limit set by the strength of the shank of the tool.

The lathe is fitted with patent chasing saddle in which chasing is done by means of a leader enabling any required pitches to be cut without any danger of cross threading, and without rendering it necessary for the lathe to be reversed.

The movement for engaging the nut with the leader also engages the tool with the work, the reverse movement withdrawing the tool and disengaging the nut. The leader, being removable, can be made with a pitch which bears an even ratio to the pitch to be cut, thus preventing danger and doing away with all difficulty in engaging the nut in the proper place.

Each leader will cut four pitches, these pitches being determined by the lower of the two handles in the feed-box, and the screws produced may be either right or left hand, the hand being determined by the upper of the two levers.

The capstan slide itself is adjustable along the bed and has six automatic feeds. It has also six independent automatic stops, one for each tool in the turret. These stops are carried by a hexagon bar at the front of the capstan slide, and this bar is geared so as to rotate with the capstan, so as to bring the correct stop into operation at the proper time.

In many cases, especially when used for making motor car gears from solid bars, the tools are provided with automatic oil feed through them. In this way they are lubricated right on their cutting points and the pressure of the oil supply tends to wash out the hole and keep it clear from chips.

DREDGING OPERATIONS AT THE LOWER BARRAGE ON THE NILE.

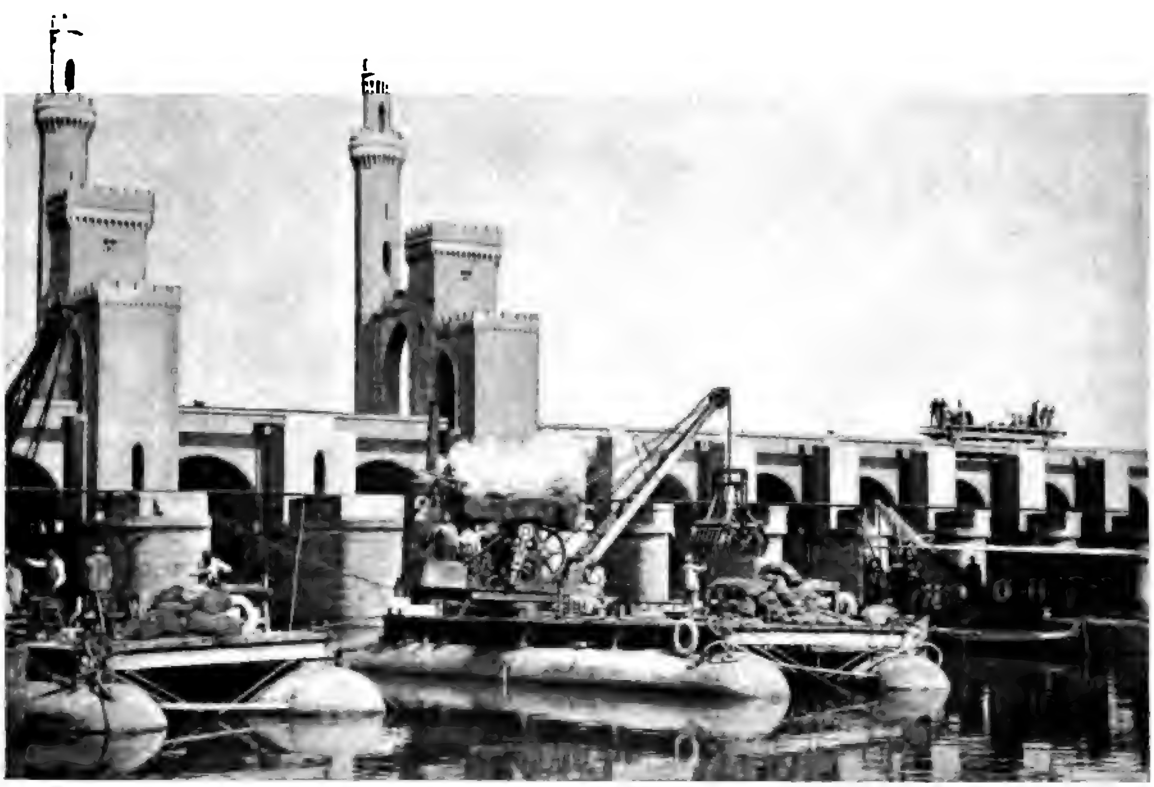
IN small dredgers for harbour and dock work, and for clearing rivers, canals, and various water-ways, the form of the bucket, or grab, generally employed has attained to such perfection that it is at present not so much the tool itself, but the method of applying the necessary power to it that engages the attention of those interested in this particular class of tool.

For certain purposes, buckets, or grabs, of single-chain type, worked by a single chain, and capable of attaching to and working from an ordinary single chain-lifting crane, can be, and are to a certain extent, advantageously employed; but for all-round dredging or excavating, these single-chain grabs are open to various objections when compared with grabs of the double-chain type, worked from suitable cranes of special design and construction.

In the dredging operations at the lower Barrage, on the Nile, it was found advantageous to use the "Kingston" type of double chain grab dredger, made by Messrs. Rose, Downs, and Thompson, Ltd., of Hull and London. The accompanying illustration shows several of these handy and efficient machines in operation.

In the "Kingston" dredger all the wearing parts are in the machine itself and not in the grab, so that when dredging amongst heavy sand, shingle, etc., there are no intricate parts to become damaged or unduly worn. The grab is actuated by two chains. One of these opens it for a fresh lift, the second chain being worked from a small auxiliary winch—an advantage which renders the crane distinct from any other type. The driver has thus full control over both chains, and can instantly open or close the grab at will in the event of a misfit being made, or the grab closing on something which it is unable to lift. This is, of course, a matter of considerable importance when very stiff material is encountered, as it would give the grab a pecking or scraping movement, thus aiding the ultimate lift.

The machines illustrated are mounted upon double cylindrical steel pontoons, which are found to be most suitable for the particular work in question. The capacity of the "Kingston" varies between 30 and 500 tons per hour.



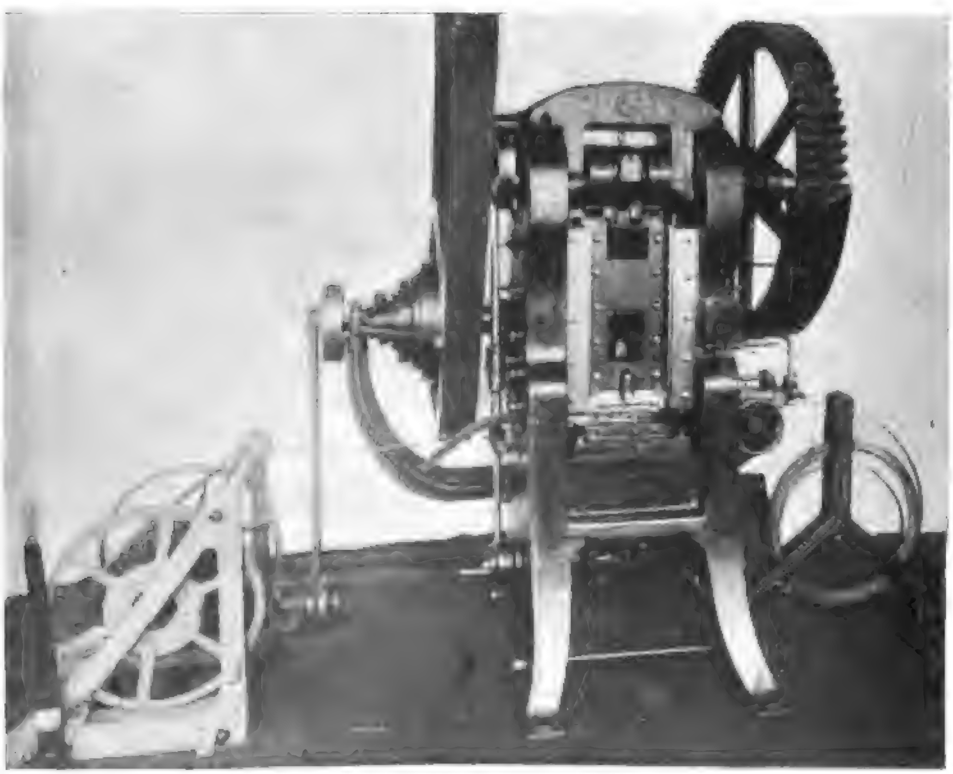
"KINGSTON" DREDGERS EMPLOYED ON THE RECONSTRUCTION OF THE LOWER BARRAGE ON THE NILE.

MODERN CHAIN MANUFACTURE.

THE machine here illustrated may be described as a marvel in mechanics, for it is fed with hoop steel on the one side and disgorges finished chain of the "detachable" type on the other. Hitherto, detachable chain has been made only of cast-iron which had to pass through no less than seventeen different operations in the course of its manufacture, whereas the Locke Steel Chain is made by a series of five operations with a series of ingenious dies. It is impossible within the space at our disposal to follow the intricacies of the process; suffice it to say that instead of taking the chance product of castings, the Locke chain is scientifically made—both in construction and composition it is altogether subject to control. For instance, links can be made to detach easily or with difficulty, and may be produced of any design or strength.

The soft steel after being made into chain is hardened and tempered by a special process, rendering it proof against the jerks and jars that are so liable to break chains in actual work.

The Locke Steel Chain Company, of 18, Bishopsgate Street Within, have acquired the entire European patents connected with the invention, and have erected a factory at South Tottenham for the manufacture of the chain.



AUTOMATIC MACHINE TURNING OUT FINISHED CHAIN FROM A BAND OF HOOP STEEL.

A TRANSFERABLE STEERING PROPULSOR,

Which dispenses with the encumbrance of transmission gears and clutches, reversing gears and rudder.

A NOVEL apparatus for propelling and steering boats is the Universal Transferable Steering Propulsor illustrated herewith, its most interesting feature being the gyratory movement of the screw-box through the entire arc of a circle, which enables the helmsman to turn the boat within its own length. Economy of working and maximum speed are also claimed for the apparatus, which, we understand, is already used in the navies of France, Russia and Japan. The apparatus comprises a motor with special carburettor, a horizontal frame, vertical arm, and the screw-box and screw, movable around a vertical axis. The motor acts directly upon a shaft passing through the horizontal frame, which in turn, by a system of gearing, transmits to a vertical shaft enclosed in the vertical arm, and thence communicates to the screw the rotary motion necessary for propulsion. The screw-box is kept in position at the lower extremity of the vertical arm by a movable tube passing through the arm, the upper portion of the tube ending in a pinion controlled by a shaft passing outside of the horizontal frame, to which the steering-wheel is attached.

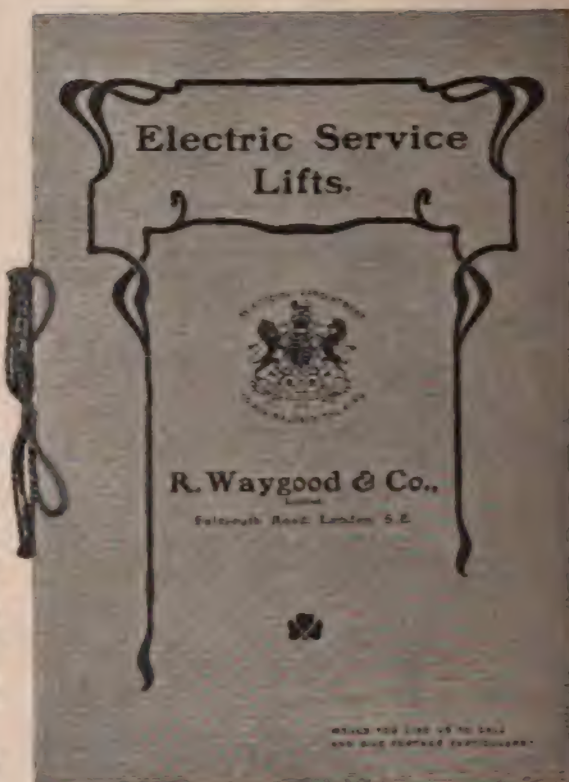
In this way a gyratory movement is given to the screw for steering purposes, and it can be turned horizontally in any direction.

Numerous applications for such a device suggest themselves in connection with life-saving, commerce, or pleasure boats, and not the least important feature of the apparatus is that it can be transferred from one vessel to another.

Being independent from the hull of the boat, the propulsor does not transmit the motor's vibrations, and, consequently, the resulting strains on the ribs of the boat are small, while, as the apparatus occupies a minimum of space, *the whole of the boat is available* for passengers or cargo.

For the illustration and particulars we are indebted to Mr. W. R. B. Lockie, of Liverpool.

CATALOGUE DESIGNS . . .



SOME attractive cover designs are illustrated this month, though as colour plays a very important part in both, we are unable to do full justice to the originals.

One of the most tasteful designs we have seen lately is forwarded by Messrs. R. Waygood and Co. The line work is forcible without being redundant and is executed in dark green, upon a most ingenious background made up of cross-hatching. The royal arms appear in red, which colour is also chosen for the dainty silk bow with which the brochure is tied. The interior is in keeping with the clever cover, the text being printed in red type, while the half-tone blocks are of the best.

We are reviewing Messrs. Broadbent and Sons' latest effort in another part of the Magazine.

This collection of admirable views is bound in a highly artistic cover for which a subdued shade of green has been chosen. The wording and lighter parts of the design appear in mat silver and are thus thrown into high relief. The darker part of the cover is produced in electric blue and metallic purple, which gives an exceedingly rich *tout ensemble* to the cover. The interior is elegantly printed on the finest art paper.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel Mining and Allied Industries.

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Telephone No: 3349 GERRARD.

Telegraphic and Cable Address: "SINEWY, LONDON."

Editorial.—*All communications intended for publication should be written on one side of the paper only, and addressed to "The Editor."*

Any contributions offered, as likely to interest either home or foreign readers, dealing with the industries covered by the Magazine, should be accompanied by stamped and addressed envelope for the return of the MSS. if rejected. When payment is desired this fact should be stated, and the full name and address of the writer should appear on the MSS.

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OUR MONTHLY SUMMARY.

LONDON, March 22nd, 1904.

Our Navy.

The war in the Far East has already provided us with an object lesson on the value of an efficient navy which can scarcely fail to have impressed those who are inclined to grumble at our rising navy estimates. Efficiency unquestionably is the keystone of the policy which governs at the Admiralty to-day, and while this is so, Britain can certainly afford to pay and pay handsomely for all that the navy means. The estimates for 1904–05 provide for an expenditure of £36,889,000, which means an increase of £2,432,000, part of which is accounted for by the larger part of the cost of the *Triumph* and *Swiftsure* being debited to next year's account.

The ships at present under construction include eight battleships, thirteen armoured cruisers, one second-class cruiser, four third-class cruisers, eight scouts, twenty-three destroyers, eleven submarines, a river gunboat, and the new Admiralty yacht. Two battleships, four armoured cruisers, fourteen destroyers and ten submarines will be commenced during the financial year 1904–05. The acquirement of the Chilian battleships has necessarily modified last year's programme so that only two new battleships will be laid down and these will be commenced in the autumn instead of in April. They will be known as the *Lord Nelson* class and will be the first of a new type of warship, with very heavy armament.

Steady progress has been made with the work of reconstruction announced two years ago, and in the current year steps have been taken which will greatly increase the efficiency of the dockyards which are to be completely furnished with electric light and power, while the obsolete machinery of which we have heard occasional complaints is to be replaced with appliances of the latest type. It is also very satisfactory to know that in no country have more careful experiments been made with regard to the utilisation of oil fuel in the navy.

The Best Guarantee of Peace.

Our position with regard to the Navy was well put by Sir George Sydenham Clarke, K.C.M.G., R.E., in a paper which was printed by the order of the Victorian Senate in June last, and, in view of subsequent events in the East, it is doubly interesting at the present moment.

"Great Britain," said Sir George, "has a distinct superiority in battleships and in cruisers over the two next Powers. In first-class battleships completed we shall next year be equal to any three Powers. Our total naval expenditure is now nearly equal to that of France, Russia, and Germany combined, and we can build warships more quickly and more cheaply than any of these Powers. The important alliance with Japan would, in certain contingencies, bring seven battleships and thirty-three cruisers, all concentrated in the China seas, into line with the British Navy, and no European fleet is more efficient in proportion to its numbers, or manned by better fighting men than that of Japan. A feverish naval competition still continues, and is most marked in the case of Germany and the United States, while Japan has lately had the patriotism to lift her Navy out of the sphere of party politics. France of late slackened

somewhat in building battleships especially, but is now building six of the first class; Russia continues steadily to increase both battleships and protected cruisers.

Position of the British Navy.

"I consider that our present position is satisfactory Both absolutely and relatively, to probable enemies, the British Navy has never been so strong, or so efficient in peace time as it now is; but this result has been attained only in recent years, and by strenuous efforts. During last century there were periods of dangerous weakness. We had ignored the plain lessons of our history; we lived upon the prestige of the past, and we courted disaster. There can be little doubt that our marked efforts since 1889 to build up the Navy have stimulated a competition which would not have become so acute if we had maintained a consistent policy. Our naval estimates have been doubled, and their present amount, more than £34,000,000, exclusive of India and the Colonies, must throw strain upon our resources, especially as we have not yet adapted our military organisation to our real requirements, and our normal Army expenditure has mounted up to more than £27,500,000, not including the cost of over 70,000 Regular troops serving in India. In view of these enormous figures, I think that you will agree that the mother country is fully alive to her vast responsibilities, and is making splendid efforts to maintain that supremacy at sea which is the surest guarantee of peace, and which in war is the only means of guarding the commerce upon which the Empire, and most especially Australia, absolutely depend. On two recent occasions, at the time of the Fashoda incident, and during the critical period of the South African campaign, the Navy stood directly and effectually between the nation and a great war.

"There are some persons who seem to find pleasure in discovering special sources of danger to the Empire, and you may have been told that the sea is an 'unstable element,' that naval operations are, therefore, uncertain, that changes in ship-building and in armaments have operated to our disadvantage, and that the lessons of the past are valueless in view of the unknown conditions of the future. I ask you to reject unhesitatingly all such suggestions. Our history proves conclusively that, while the land has proved too frequently treacherous, the sea has been our constant ally, always faithful except when we have neglected its claims."

The Submarine Tragedy at Portsmouth.

During the month the loss of the submarine *A 1* with all on board under such tragic circumstances has cast a gloom over Portsmouth, and, indeed, throughout the length and breadth of the land, from His Majesty the King, who recently inspected the submarine, to the humblest colleague of the gallant men who died at the post of duty. For anything approaching this terrible affair we have to go back to the attack on the *Housatonic* in the days of the American Civil War when, as told by Mr. Burgoyne in his fascinating work on submarines, the attacking submarine *David* became wedged in a hole in the side of the doomed warship and the nine men who formed her crew were drowned. The dangers of submarine warfare, even in times of peace, are only too obvious. The wonder is that, in the development of the submarine, disasters have not been more frequent. The sad affair at Portsmouth will, no doubt, be the subject of a searching inquiry. At the moment we can only join in respectful sympathy with the bereaved.

Invention without Incentive.

Mr. George Archibald Lowry complains bitterly in the "Society of Arts Journal" of the condition of our Patent Laws, in which he remarks there is neither encouragement, hope, nor incentive for the inventor. Your patents, says Mr. Lowry, convey no sense of ownership nor evidence of the applicants having invented anything. It is simply a certificate of registration of the application, drawings, and claims, and that they conform to the requirements of the office.

To give a patent any tangible or marketable value, it must first be fought through the courts to a decision in its favour—even if the inventor's means should permit him to do so, and he should live to see the end of the litigation, the term of his patent would probably have expired, or been materially reduced—and if he is defeated in even one claim, though he has fifty others that are good, his whole patent is declared invalid.

The English investor asks first, "Have you a United States or German patent?" Unless you have one or both of these the English patent carries no weight and his interest ceases.

Is it justice to your inventors that they must seek from a foreign country protection in their own—these foreign patents are practically a guarantee that "you are the sole and original inventor of a new and novel device"; those who wish to invest feel safe, and those who infringe do so at their peril.

Your Government has not even the excuse of "expense," for although the United States Patent Office fees are only forty dollars (£8) the office is now over two million dollars ahead of its outlay. It would not cost Great Britain anything to protect her inventors—but instead of doing so she and her Colonies prey upon them. The inventor is made a source of revenue—to cover the simplest device with patents "under the Flag," and pay the taxes, costs over a thousand pounds.

Another correspondent of the "Society of Arts Journal" expresses the hope that Mr. Lowry's complaint may approve the starting point for a reconsideration by the Society of Arts of the whole question of British Patent Law.

Accidents to Workpeople in 1903.

The Board of Trade returns show that during the past year 4,153 workpeople were reported as killed in the United Kingdom by accidents that occurred in the course of their employment. This number shows a decrease of 170 (or 4 per cent.), as compared with 1902, and was lower than in any year since 1898. An analysis of the figures for 1903 shows that the 1,380 seamen killed by accident included 920 employed on steamships, and 460 on sailing vessels. These figures give 1 death for every 223 persons employed on steamships, and 1 for every 93 employed on sailing ships. Wrecks or casualties to the vessels accounted for 622 out of the 1,380 deaths. Of the 1,097 deaths among miners, 1,072 occurred through accidents at mines under the Coal Mines Regulation Acts, and of these, 567, or more than half, were occasioned by falls of roof or side. The returns of fatal accidents to railway servants show that of the 459 killed in 1903, 94 were permanent way men, 49 porters, 37 shunters, 34 brakesmen and goods guards, and 245 in various other occupations. Among the 742 factory workers killed, the greatest number of deaths in any one group of occupations was in the founding and conversion of metals, viz., 107, followed by 90 in ship and boat building, 65 in textile factories, and 48 in the extraction of metals.

Improvements in the Reciprocating Engine.

A good deal of attention was given to the question of superheating by Mr. John Mills, in the course of a paper on Improvements in the Working of the Steam Engine, read before the Staffordshire Iron and Steel Institute. Superheating is a subject which, in the opinion of Mr. Mills is destined to receive more and more consideration. He remarks that if a superheater can be brought into the market that will, as Professor Watkinson states his will do, last as long as the boilers to which it is connected, and will be free from the defects of most types hitherto in use, superheating will, no doubt, be more generally adopted; for in this direction lies the chief future economy in the working of the best designed up-to-date engines of the present day. The economical improvements in the reciprocating steam engine are found to be, chiefly, increased piston speeds, the use of higher pressures in (1) the single cylinder, (2) in the compound engine, and (3) in the triple and quadruple engines; great reduction in the clearance spaces, improvements in the proportioning for the pressure and work to be done in multi-cylinder engines, and the use of superheated steam. Whether the reciprocating engine, with all the improvements applied, has reached the zenith of its usefulness, and is to be superseded by the gas engine using producer, furnace or other gas—or that the rotary engine (as some of the prophets say) will in a short time oust both—Mr. Mills does not pretend to say. In his opinion, the reciprocating engine will not be scrapped just yet. "Threatened lives live long."

More about the Proposed Thames Dam.

We hope to give more attention in an early number of PAGE'S MAGAZINE to the proposal of Mr. T. W. Barber, M.Inst.C.E., to construct a dam across the Thames at Gravesend, as briefly outlined in our March issue.

Of course, many objections are likely to be encountered in the furtherance of this scheme. For instance, a correspondent in the "Times" wants the following questions answered :—

(1) What will be the effect upon the climate of London and the health of its citizens of a huge and, comparatively speaking, stagnant lake of fresh water set in their midst?

(2) Is not the present constant passage to and fro of salt-water tides through the heart of our city, with the currents of sea air that always go with the ebb and flow of the tide in a river channel, one cause of the comparative good health of Londoners?

(3) Will winter fogs, our worst climatic enemy, decrease or grow worse by reason of this great London pool?

(4) Will the more or less dead waters of the said pool, containing, as they will, the accumulated sewage outflow of the up-river towns, with so much of that of London as is not carried down Thames, be so very clear and clean as the promoters of the scheme contend?

To these questions Mr. Barber replies categorically as follows :—

(1) The effect of a fresh-water lake upon health and climate of London will be wholly beneficial by (*a*) the abolition of mud banks; (*b*) the removal of the polluted zone of the river—now extending from Richmond to Erith—far below London, that is, from Woolwich to Greenhithe; (*c*) the conversion of a mixed, muddy, rapid stream into a quiet, fairly clear, slow-moving lake of fresh water; (*d*) keeping the river always full. There will be no more stagnation in the Thames lake than in other lakes.

(2) The "constant passage to and fro of salt-water tides, with the currents of sea air that always go with the ebb and flow," etc., is a pure myth. The salt water interferes with and retards the natural purification of the river, and the sea air has no existence in the Thames valley except in imagination, for the wind "still bloweth where it listeth," tide or no tide.

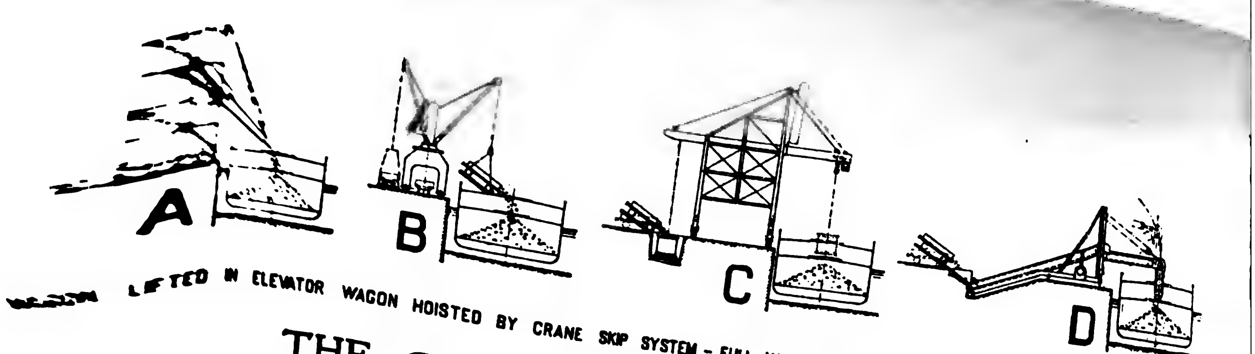
(3) Winter fogs.—If the opinions of all river people are correct, that fogs come up with the tides, the dam should effect an improvement in this respect.

(4) "Accumulation of sewage in the dead waters of the lake," etc. There will be no dead waters, and sewage does not accumulate in a river or lake; all rivers purify themselves of organic pollution by natural bacterial oxidation. Drs. Debdin and Dupré have both shown that the Thames has ample upland water to oxidise all its pollution, which is even now effected before it reaches Gravesend, and will be more rapidly effected when the tides are kept out.

Mr. Barber also remarks that the proposed dam would provide the best possible security against foreign invasion *via* the Thames, as it could be easily fortified. Tilbury Fort, which dominates it, would become a valuable military asset.

The National Physical Laboratory.

The report of the National Physical Laboratory for 1903 contains full details of the work which was carried out during that year, and also an outline of the programme for the present year. In the engineering department this includes a continuation of the research on wind-pressure and of that on the mechanical properties of nickel-steels, undertaken jointly with Mr. Hadfield; an inquiry into the specific heat of superheated steam on a large scale; the erection and testing of the new screw-cutting lathe, for which a special house has been built and which is to be used for making standard leading screws on behalf of the Standard Leading Screw Committee of the War Office; and the construction of a machine for determining the friction of bearing surfaces. In the physics department, among other things, the construction of a standard ampere balance, together with various electrical tests, is to be undertaken for the Engineering Standards Committee; various methods of measuring temperatures between 1,400° C. and 1,800° C., and the suitability of different glasses for high temperature thermometry, are to be investigated; the standardisation of the steel yard and nickel metre is to be completed, and the urgently required work of comparing an "end" yard and an "end" metre with the "live" standards and of calibrating the sub-divisions of each is to be undertaken; and an inquiry is to be initiated into the conditions in which the pentane lamp may be treated as a standard, and measurements made of the refractivity and absorption of various glasses used by opticians. During last year 1,330 tests were made in the engineering and physics departments. The receipts for 1903 were £10,200 and the expenditure £10,306, the deficiency thus being £106. The committee holds that an increase of funds is necessary even to maintain the work as at present, and a further increase if work for which there is a demand is to be carried out. It also thinks that, for the sake of permanence, the positions of the senior members of the staff should be made more secure, and that the stipends now paid to the assistants—with one exception £200 a year—are not commensurate with the work and are insufficient to retain for long the services of suitable men, while in addition, the staff is now too small.



THE CIVIL ENGINEER AT WORK.

BY C. H.

The Mechanical Shipment of Coal.

"The Mechanical Shipment of Coal: a brief account of some of the principal systems in use in Great Britain and other countries, with a note on the system recommended for the Calcutta Docks"—such is the title of a work that will be found of great interest by all engineers who are in any way connected with the shipment of coal. The author is Mr. E. Herbert Stone, M.Inst.C.E., Chief Engineer of the East Indian Railway, and the work, which is published at the Bengal Secretarial Book Depot, can be obtained of Mr. Arnold, Messrs. Constable and Co., and several other officially appointed agents. The greater part of the coal exported from Bengal is shipped from the Kidderpore Docks, Calcutta, and it has been found necessary to give very careful consideration to the different systems of mechanical shipment with a view to the provision of a permanent installation. The author has included a valuable collection of notes, drawings, and photographs, which should serve to elucidate the problem.

To meet the conditions and requirements laid down, the four systems considered most suitable are as illustrated above, viz.:—(*a*) Wagon lifted in elevator and tipped into shute, as at Barry, Newport and elsewhere; (*b*) wagon hoisted by crane and slung over ship, as at Glasgow, Fleetwood and elsewhere; (*c*) skip system; (*d*) endless chain and bucket system.

It will be understood that for (*b*) and (*c*) systems either a radial jib crane or traverser crane may be used, whichever may be considered more efficient. System (*a*) is finally preferred, on the grounds of economy and efficiency. The rate of working possible on this system is about one minute per tip, approximately as follows: (1) Lift (loaded), 30 seconds; (2) tip, 10 seconds; (3) lower (empty), 20 seconds. Total, 60 seconds. With wagons holding twenty tons, this would give a possible delivery of about twenty tons per minute, or 1,200 tons in an hour.

The author remarks that against system (*a*) it has been stated that it is more liable to cause breakage of the coal than would be the case with skip systems or chain and bucket systems, under which the coal is deposited in the hold of the ship with a minimum of fall. But with the anti-breakage boxes (now in general use with the elevator system) this breakage is much reduced, and with the coal to be dealt with in Calcutta it does not appear likely that there would be more difficulty in this respect than in South Wales, where this system is preferred.

Mechanically, system (*a*) is in all respects an excellent one. The load is dealt with direct and in the most efficient manner, the arrangement being such as enables the requisite strength and lifting power to be secured to the best advantage. The result is that the machine will deal with larger loads at a lower cost, and with greater speed than other machines not having these advantages.

Civil Engineers in Conclave.

An International Engineering Congress, under the auspices of the American Society of Civil Engineers, will be held at the Universal Exposition, St. Louis, Missouri, U.S.A., during the week of October 3rd to 8th, 1904. As a basis for discussion at the sessions of the Congress, the Committee has invited engineers specially qualified in each of the various branches to prepare a review of the development during the past ten years in that branch in the United States, together with a summary of present practice. Engineers in other countries, experienced in these various lines, will be specially invited to prepare similar papers presenting a review and summary of practice in their respective countries. It is proposed to print these papers in advance, in order that a full discussion at the various sessions may be elicited without giving up any time to the reading of papers at the congress. All engineers in the United States and in all other countries are invited to become members of the congress, to attend the sessions, and to take part in the discussions; or, if unable to attend, to forward written communications on any of the selected subjects. It is not expected that delegates will be formally appointed, it being intended that an opportunity to attend shall be afforded to any who may wish to become members of the congress. The following are included in the list of subjects:—

Natural and Artificial Waterways; Lighthouses and other Aids to Navigation; Traffic on Improved Waterways, as Compared with Seaboard Traffic, and the Effect of this Development on Railroad Traffic; Purification of Water for the Production of Steam; Turbines and Water Wheels; Railroad Terminals; Underground Railways; Locomotives and other Rolling Stock; the Substitution of Electricity for Steam as a Motive Power; Disposal of Municipal Refuse; Ventilation of Tunnels; Passenger Elevators; Pumping Machinery; Steam Turbines; Electrical Power—(*a*) Generating Stations, (*b*) Transmission; Mining Engineering; and Engineering Education.

Obtaining the Best Results from Concrete.

At a recent meeting of the Society of Engineers a paper was read on "Some Recent Works of Water Supply," at Penzance," by Mr. Frank Latham, M.Inst.C.E.I., Borough Engineer and Surveyor, Penzance. The author described in detail the construction of the service reservoir, which was built on the Hennebique Ferro-Concrete system, and was the

first reservoir constructed under the Hennebique patents to receive the approval of the Local Government Board. Particular stress was laid upon the care and knowledge required in selecting materials and putting them together in order to obtain the best results from concrete. He remarked that the too common practice of entrusting this kind of work to inexperienced persons, with the notion that concrete making is but a matter requiring ordinary intelligence, chiefly in that the proper quantity of cement is used, is most erroneous, and calculated to court disaster. Having recently made scores of briquette tests, he has not infrequently found that a practical gauging with less cement will give a higher result than an inferior gauging with a greater proportion of cement.

The author made ten briquettes from material taken from the works of the Penzance sea wall. In some cases the materials were carefully measured in accordance with the stereotyped specification: 1 of cement to 4 of sand, etc.; and in others, care and judgment were used, placing a little finer sand to the mixture and a larger proportion of sand to fill up the voids in the gravel. These briquettes were proportioned 1 to 4, as in the case of the others, also 1 of cement to 7 of aggregate, and the result was that the 1 to 7 briquette stood 115 lb. tensile strain, and the other stereotype mixing in the proportion of 1 to 4 stood but 45 lb. after twenty-one days' immersion in water in each case. On examining the careful gauging of 1 to 7, and comparing it with samples containing a higher percentage of cement, it was to be observed there was the appearance of excess of cement showing on the top trowelled surface of the former, and insufficient cement in the latter, although the proportions in which the cement was actually used were the reverse.

Railway Progress in Switzerland.

According to a "Times" correspondent, two rival projects are at present being discussed in Switzerland for a new railway to pierce the Alps and extend communication with the north of Italy. One is by way of the Greina, which would emerge in the Canton of Ticino, some 20 kilometres (12½ miles) east of the Gothard route, and, as its advocates maintain, lie almost entirely on Swiss soil. The other route proposed would pass under the Splügen, by a continuation of the Chur-Thusis railway, and would, it is maintained, develop the rich country south of Chiavenna in the province of Como, by bringing it into closer connection with East Switzerland and southern Germany. In either case, an eastern Alpine railway lying between the Gothard and the Brenner routes cannot fail to become of international importance. A third railway project, which has just been approved by the international experts, is to connect Berne with the Rhone Valley and the Simplon route, by a line running due south from Berne through the Wildstrubel into the Canton of Valais. The longest tunnel is to be 8½ miles, and the time of its construction 4 to 4½ years. This would do away with the roundabout journey from Berne *via* Lausanne into the Rhone Valley, and create a direct international route from Paris to the Simplon.

The Cape to Cairo Railway.

Reuter's Agency is informed that the Cape to Cairo Railway will reach the Zambesi at the Victoria Falls in the course of next month, and that the first through train from Cape Town to the Zambesi will run in April or May. On February 1st the rails were within forty-eight miles of Victoria Falls, and excavations for the great bridge which is to span the Zambesi were in active progress. The first portion of the bridge work is now on its way to South Africa, and will be followed by the remaining sections as rapidly as possible, so that the erection of the bridge may be completed this year. With the setting up of the bridge and the completion of the line to that point the present contracts expire.

The next section of the line to be built will be from the Zambesi north-east to Broken Hill, a distance of 350 miles in the direction of Lake Tanganyika.

Under favourable circumstances the Trans-Siberian Railway should bring London within nineteen days of Japan. The actual distance to Port Arthur is 7,367 miles. The construction of the Chinese Eastern (Manchurian) Railway was described in PAGE'S MAGAZINE of July, 1903.

SHIPBUILDING NOTES.

The Shipbuilding Quarter.

By the time these lines are in the hands of the reader we shall have reached the end of the first quarter of the shipbuilding year. The quarterly totals, of course, are not available as we write, but we have sufficient information to show that the output has been considerably short of the corresponding portion of 1903. And the trouble is, as far as the industry is concerned, that month by month the comparison with last year will now become more and more unfavourable. This is not surprising from the point of view of the shipowner, who well knows how unprofitable shipping has been for the last year or so; but in practice the shipyard does not care whether the steel work or the ship is making money, so long as it has plenty of employment for its own hands. And that is what it has not at present, nor is likely to have this year, although one may reasonably infer that the war in the Far East will by-and-by cause some changes in the industrial conditions. One must remember that the engagement of most of the merchant fleet of Japan in warlike services, and the retention of the Russian Volunteer Fleet by the Russian Government, have caused gaps in the streams of ocean carriers which must be filled up somehow. Nor can the war pass over without considerable damage to the merchant shipping of the belligerents, and detention of that of neutrals. What we mean is that the war will probably cause some improvement in freights, which will incite British shipowners to order more vessels—especially if there is (as is probable) some demand for second-hand ships for transport. But this is a prospective effect, which cannot be felt for some time.

The Districts.

It is true that there has been considerable improvement in the North of England shipbuilding districts since the beginning of the year, and that the improvement there has served to better the Clyde district. But after all, the new contracts which have been announced do not extend to all the yards nor fill up any of them. There are a few yards, especially those with Admiralty and liner work on hand, which are very well employed, and which regard the future with complacency. But there are very many with very little on hand, and with nothing to look forward to. Moreover, the merchant work which is being booked by shipbuilders just now cannot be on remunerative terms—there is so much cutting when specifications are submitted. Shipbuilders are neither more greedy nor more generous than their neighbours, but like most large employers of labour, they deplore seeing their men put out of employment. To keep their hands together and their plant employed they are willing enough at times to sink all considerations of profit. In fact, it is extremely doubtful if any recent contract for merchant craft will cover the standing charges in addition to labour and material, and it is highly probable that many of the contracts will leave a dead loss. Unfortunately for shipbuilders, material has gone up, although wages have gone down to a partial extent. In Scotland, for instance, the steel makers have combined to put up steel ship plates to £5 15s., less 5 per cent., with angles and other material in proportion. And they have bound themselves under heavy penalties not to sell below the prices fixed in combination in either Scotland or Ireland. This might afford an opportunity to English makers to dump in the Scotch markets, but the English makers are kept occupied with local orders, and do not need to go across the Border at present. Moreover, a strong attempt is being made to bring the English makers into the combination.

Material and Wages.

As ship plates were selling previously as low as £5 net, if not lower, it will be seen that the changed position is very disadvantageous for the builders. Those who accepted contracts on the £5 basis are bound to suffer, if they did not cover their material at the time. On the other hand, they will save a little in wages. Since January 6th the "black squad" in the North-east of England have been working on a reduction of 5 per cent. on piece rates, applicable to all the iron workers. Equivalent reductions proposed to the A.S.E. men and machine workers were rejected by them, and the employers decided to defer the matter for six months, as a little spurt of new business had set in since they proposed the reduction. In Scotland the 5 per cent. on ironworker's piece rates has been in force only since February 26th, and the engineers and machine workers have not been interfered with at all. But it is evident to the dispassionate observer that wages in the shipbuilding industry will soon have to be dealt with by a broad and firm hand. The reward of labour in the industry is far beyond its intrinsic value, and the development of almost supernatural machine tools is working a silent revolution.

Warship Building.

The leading features of the past quarter, then, have been the peaceful reduction of wages to a small extent, the advances in raw material, and (towards the close) a slight improvement in the demand for new ships. But the most striking feature has been the adoption of the turbine motor for ocean liners—first by the Allan line in the *Victorian*, now building at Belfast, and the *Virginian* now building on the Clyde, and second, by the Cunard Company, who have ordered a turbine engine to be put in the 12,000 ton ship to be built by John Brown and Co., Ltd., at Clydebank as a sister ship to the *Caronia*, now

being built by that firm. The monster fast steamers have not been contracted for up to the time of the present writing. There is a good deal of disappointment in shipping circles at the Naval programme submitted to Parliament this year, because as the result of the purchase from the Chilian Government it has reduced the amount of contract construction work in the fiscal year now before us. The reduction, however, is not general, for while the amount to be expended on the Clyde contracts is £1,982,000, as against £2,827,000 last year, that on the Thames £970,000, as against £1,645,000, that on the Mersey £495,000, as against £893,000, that at Belfast £193,000, as against £229,000, and that at Cowes £116,000, as against £130,000; the amount to be expended on Tyne contracts is the same as last year, £1,860,000, and that on Barrow contracts is more, viz., £1,575,000, as against £1,303,000.

A New Clyde Cruiser.

An interesting feature at the beginning of last month was the launch by the old firm of Messrs. Scott and Co., Greenock, of the first-class armoured cruiser *Argyll*, as no vessel for the British Navy has been constructed by this firm since they built the gunboats *Sparrow* and *Thrush* fifteen years ago, although the connection between the Admiralty and Messrs. Scott and Co. dates back to the days of the wooden walls. The first-class battleship *Prince of Wales* was, however, engined by them, and has just been handed over to the Government. The contract for H.M.S. *Argyll* necessitated the provision of suitable berthage and crane accommodation. This was not available in the usual fitting-out harbour at Greenock, and Messrs. Scott undertook to supply these requirements in their own establishment. A large fitting-out basin has been made, which will be equipped with a 120-ton electric derrick crane, now in course of erection. The keel of the *Argyll* was laid in September, 1902, the first rivet being put in by the Controller of the Navy during a visit to the yard. The *Argyll* is one of the six armoured cruisers of the *County* class, the last of which—the *Devonshire*—will be launched from Chatham Dockyard in the course of a month or two. Her principal dimensions are:—Length, b.p. 450 ft.; breadth, 68 ft. 6 in.; depth moulded, 38 ft. 6 in.; mean draft, 24 ft. 9 in.; displacement, 10,700 tons; i.h.p., 22,000 tons; speed, 22½ knots. The hull was in a very advanced stage of construction at the time of the launch, and the launching weight was consequently greater than in the case of any of the other cruisers of this class when put into the water. More than the usual amount of machinery was also on board prior to launching.

British Gains and Losses.

The net total addition to the steam tonnage of the United Kingdom in 1903 was 1,008,756 tons gross, and of sailing tonnage 34,595 tons gross—in all 1,043,351 tons gross. About 93·5 per cent. of the tonnage added to Lloyd's Register consists of new vessels, nearly all built in the United Kingdom. The additions by vessels transferred from foreign countries and from British Colonies to the United Kingdom amounted to 55,086 tons, or about 5·3 per cent. of the total. The gross deduction from the Register amounts to 626,422 tons. About 39 per cent. of the steam tonnage and 54 per cent. of the sailing tonnage were removed on account of loss, breaking up, dismantling, etc. The tonnage transferred to foreigners during 1903 was 300,474 tons. The steam tonnage deducted on this account is 250,436 tons, and the sailing tonnage 50,038 tons, or about 49 per cent. and 42 per cent. respectively of the gross deductions in each case. Some 74,931 tons were transferred to Italy, and 49,370 tons to Norway within the year, while Germany got 27,553 tons, Japan 23,350 tons, and Belgium 21,450 tons. In the main, the vessels transferred to foreigners were not of very recent construction; nearly 34 per cent. of the tonnage removed from the Register sold to foreigners was built before 1880, 59 per cent. before 1885, and 71 per cent. before 1890. In addition to the tonnage transferred to foreigners, 62,907 tons were transferred to British Colonies during 1903, as compared with 32,603 tons in 1902, and 59,296 tons in 1901. On the whole, during 1903 the steamers on the official Register of the United Kingdom increased by 319 vessels and 500,108 tons; while sailing vessels decreased by 113 vessels and 83,179 tons. The total number of vessels on the Register, therefore, increased by 206, and the total tonnage by 416,929 tons. During 1903, 618 new vessels of 1,099,249 tons were classed by Lloyd's Register. Of these vessels 573 of 1,053,640 tons were steamers, and 45 of 45,609 tons were sailing vessels. Practically all the tonnage classed was built of steel. Sailing tonnage, which formed 25 per cent. of the total tonnage classed in 1891, 30 per cent. in 1892, between 1 and 2 per cent. in each of the years 1899 to 1901, and 5·7 per cent. in 1902, forms 4·1 per cent. of the total classed in 1903. Of the tonnage classed during the year 900,599, or 83 per cent., were built in the United Kingdom. Among foreign countries, the United States of America, Italy, Germany and Holland contribute the largest amount of tonnage.

The Premium System and the Home Dockyards.

The Notice to Workmen, printed on the following page, is a reduced facsimile of a document which has a very important bearing upon the economic working of the dockyards. A covering note from the Admiralty states that it has been already placed in certain of the workshops in His Majesty's home dockyards, where the premium system is being introduced for trial. The experiment will be watched with the greatest interest, and is significant of the forward policy that obtains at the Admiralty. The ready co-operation of the men should be ensured by the concluding paragraph alone, which states that increased energy and industry on the part of the workmen, added to such improvements as may be adopted from their suggestions, and resulting in work being done in less time than hitherto, will immediately benefit them by increasing their "premium" earnings.

New Floating Coal Depot.

The floating coal depôt launched by Messrs. Swan, Hunter and Wigham Richardson, Ltd., from their Wallsend yard, and intended for the Navy, has a storage capacity of 12,000 tons—11,000 tons in hoppers and 1,000 tons in bags, its output being at least 500 tons per hour. The twelve Temperley transporters are carried on four travelling towers, and are worked by electrical machinery. They are capable of reaching 20 ft. beyond the side of the depôt, and of lifting coal to a point 33 ft. above water level.

ADMIRALTY.

27th February 1904.

NOTICE TO WORKMEN.

On March 14th, 1904, the Premium System of Payment for labour will be introduced in this shop. At first it will be applied to certain classes of machine work, and if satisfactory results are obtained, the system may be extended.

The system will enable workmen to earn, in addition to their ordinary weekly wages, extra remuneration for doing work in less time than the fixed time allowed for it.

The system may be briefly described as follows:—

When a piece of work is given out, a certain time, based on known times taken for similar work done on ordinary time in this shop, will be allowed for it.

This time allowance will include all the necessary time for obtaining tools and materials, preparing the machine and lifting and setting the work in or on the machine, any removal and resetting, change of tools, and removing work after completion.

If the work is satisfactorily completed in less time than the fixed time allowed for it, the workman becomes entitled to a premium varying in amount with the time saved.

If on the other hand he takes longer than the time allowed, he will still be paid his ordinary wages.

From this it will be seen that while the workman may increase his wages by his own individual effort, he cannot lose money by the introduction of the system.

Premium will be calculated as follows:—

The value of a "premium hour" will be considered to be 1/48th of the workman's weekly wages, and the amount of premium earned on a job will bear approximately the same relation to the ordinary wages due for the time taken to complete it, as the time saved bears to the time allowed.

To give an example:—

Suppose a man is given 48 hours to do a job and does it in 36 hours, he saves 1/4th or 25 per cent. of the time allowed, and accordingly will be credited with 25 per cent. of the time taken to do the job, which is 9 premium hours, so that

> A mechanic in receipt of 36s. per week, and whose "premium hour rate" would therefore be 9d., would receive 9 × 9d. = 6s. 9d. premium for this job in addition to his ordinary wages for the period worked.

Similarly:—

> A skilled labourer in receipt of 24s. per week, and whose "premium hour rate" would therefore be 6d., would in the example quoted above receive 9 × 6d. = 4s. 6d. premium.

A convenient way for the workman to calculate his premium is to multiply the time taken by the time saved, and divide the product by the time allowed, all times being taken in hours. This will give the premium in hours which, multiplied by the "premium hour rate," will give the amount of premium earned.

Or it may be stated thus:—

$$\frac{\text{Time taken} \times \text{time saved}}{\text{Time allowed}} = \left\{\begin{array}{l}\text{Premium}\\ \text{time.}\end{array}\right.$$

Taking the case already given:—

$$\frac{36 \times 12}{48} = 9 \text{ Premium hours.}$$

The time taken will be recorded to the nearest quarter of an hour.

In calculating the premium the time taken will include all the working hours from the time of commencement of a job up to the time of commencing the next job.

Overtime, and night and day shifts, will be paid for at overtime rates as at present, but will only count as ordinary hours in the calculation of the "premium."

Lost time, or absence without leave, will count in the time taken. Absence with leave will not be included in the time taken.

The working of the system will be as follows:—

Each workman on commencing a "premium" job will receive a "Job ticket," on which he will find a description of the work to be taken in hand, the date and time of commencement of the job, the time allowed for it, and other particulars as to ship or service, head of charge, &c.

On this ticket the Shop Measurer will fill in the daily time worked, and particulars of overtime, leave, and lost time, and when the job is finished the time of completion will be inserted on it to the nearest quarter of an hour.

The ticket is then to be returned to the Inspector, and if the man's next job is also to be executed on "premium," the time of commencing the new job will be the same as that of finishing the previous job.

As soon as possible after a job has been inspected and passed as satisfactory, the amount of premium earned on it will be communicated to the workman.

Premiums will be paid weekly on the Friday following the week in which they have been earned.

It is to be clearly understood that a "premium" is not earned until the finished work has been inspected and passed as satisfactory.

If a man's work when finished does not pass inspection he will receive no premium for that job unless he can make good the work in the time allowed, in which case he will receive the premium on any saving of time still remaining.

No premium will be paid on articles that turn out defective, on account of faulty material or other causes, during machining or other operations; but if one or more of several similar articles, for which a covering time allowance for the whole is given, should turn out defective, the workman will still receive any premium earned on the rest of the articles, the premium being calculated on the saving of time made on the reduced time allowance corresponding in proportion to the number of articles satisfactorily finished.

No allowance will be made in the time taken for stoppages occasioned by breaking of straps, stopping of driving machinery, or any other cause.

In cases where a job is stopped in order to undertake more pressing work, or for any other purpose, the workman will return his "job ticket" to his Inspector, and the date and time of return will be noted on it (this being the commencing time of his next job if a "premium" job). The time spent on the job up to the time of interruption will be counted as part of the time taken, and on re-issuing the ticket, the time allowance will, if necessary, be so revised as to give the workman as fair an opportunity of earning "premium" on the whole job as would have been possible had the work not been interrupted.

As far as practicable, time allowances for definite operations will not be reduced after they have been once satisfactorily established and regarded as standards, unless a new method of manufacture necessitating a revision of the time allowance be introduced. But if an established or standard time is seen to be operating unfairly to the workman, it may be increased with the sanction of the Principal Officer of the Department.

As some of the work in the Department may not be deemed suitable to be done on "Premium," it is to be understood that a man may be required to work on "premium" or on ordinary weekly time rate as occasion and the work may require.

Apprentices will not for the present be employed on "premium" work.

It is hoped that the introduction of the Premium System will lead to the workmen taking an increased interest in their work, machines, tools, and equipment generally, and to keenness on their part in pointing out to their Officers where improvements may be made and time saved, resulting in better methods of work.

It is pointed out that increased energy and industry on the part of the workmen added to such improvements as may be adopted from their suggestions and resulting in work being done in less time than hitherto, will immediately benefit them by increasing their "premium" earnings.

By Command of their Lordships,

Evan Macgregor.

LOCOMOTIVE ENGINEERING NOTES.

BY

CHARLES ROUS-MARTEN.

The Great Western French Engine.

Some particularly misleading and grossly unfair statements have appeared in the daily press with regard to the new Du Bosquet de Glehn engine on the Great Western Railway. It was stated by a prominent London daily paper that "the French engine had proved a failure" for the "usually punctual Cornishman," when hauled by her, reached Bristol four minutes late. Now this was a gross perversion of facts. It is quite true that "La France" on that occasion did reach Bristol four minutes late, but I have the Bristol times of that train for the whole month, and I find that it was invariably late, usually from ten to fifteen minutes, though drawn by British engines of the newest standard type. I myself tried it during that period with the new engine "City of London," and got to Bristol not "four," but *eighteen* minutes late. And no blame attached to the British engines any more than to the Frenchman. The reason was simply that heavy repairs to road and bridges were going on at several points, which compelled all trains to slow down to walking pace for considerable distances. An engine, however swift and powerful, cannot with prudence or safety rush heavy loads at high speeds over bridges under repairs! The consequences would be worse than the loss of four minutes!

Actual Performance of "La France."

It will be reflected by most thoughtful readers that if "La France" failed in England after her twenty sister engines had invariably done such splendid work in France, there must be something very wrong indeed—not with the engine, but with the treatment she received. But, of course, there is not a syllable of truth in the tale of her alleged failure. Now let us see what she really did when tried on the best express in the regular service "without fear, favour, or affection"; with Burden, the Royal record driver at the regulator, and Inspector Smith, of Swindon, on the footplate as "consulting engineer." The train was the 3 p.m. ex-Paddington, which makes the "longest non-stopping run in the world," viz., Paddington-Exeter, 193¾ miles, in 3 hours 30 minutes, averaging 55·4 miles an hour from start to stop, in spite of having to slow down to ten miles an hour for a considerable distance through the sharply-curved Bath station, and round the still sharper bends along the Avoiding line, by which Templemead station and its innumerable risks of "blocking" are evaded. What happened was this: The train stopped at the entrance of St. David's station, Exeter, in 3 hours 23 minutes 14 seconds from London, or 6¾ minutes under booked time. Yet it had been *twice* stopped dead for signal, for 3 minutes 45 seconds in all, and badly slowed *ten* times beside—thrice to walking pace; so that the actual net time for the 193¾ miles was only 3 hours 2 minutes 30 seconds. Moreover, the speed was carefully kept down at all the points where it is usually highest, *i.e.*, down the Wootton, Box, and Burlescombe banks, which were descended without steam on, at a very quiet pace. That train, however, is not heavily loaded in the winter, and in this instance the weight behind the tender was about 160 tons.

The Return Journey.

"La France" returned next day on the corresponding train which is booked to leave Exeter at 12.7 p.m. and to go without stop to London in 3½ hours. In this case, however, the load was much heavier, consisting of ten of the heaviest eight-wheeled vehicles, one being a large dining car. Again, there were numerous slowings for repairs to bridges and roads, seven in all, involving a total delay of eleven minutes, and once more speed was carefully eased off down the bank., notably the Wellington incline, down which we ran without any steam on, and at a far lower pace than usual. Also from first to last we were in front of our booked time, and so could not "go ahead" without the certainty of checks by slower trains which preceded us. Nevertheless, we completed the entire journey of 193¾ miles in 3 hours 28 minutes 51 seconds inclusive, or in 3 hours 17¾ minutes, allowing for the delays, and this with a load of 275 tons behind the tender. Manifestly this was excellent work, although not equal to some of the performances on the other side of the Channel by the French sisters of "La France," which I have recorded in these columns. So she still has "a lot in hand."

A New Great-Wester.

It is understood that a lengthened competitive trial will be made between "La France" and a Great Western engine of the latest British type, and that the newest of all has been specially constructed with this view. She is numbered "171," and is named "Albion"—a rather felicitous designation, if she is to compete with "La France." I have had two recent opportunities of inspecting her at Swindon, and she undoubtedly is an exceedingly "likely" looking machine. Practically, she is a replica of No. 98, with higher steam pressure, and consequently a stronger boiler—stronger, I mean, in the sense of having thicker plates, and so being able to stand the enhanced pressure of steam. Like No. 98, "Albion" has a leading four-wheel bogie, outside cylinders 18 in. diameter, with a 30 in. piston stroke; six coupled wheels 6 ft. 8 in. in diameter, and 2,143 square feet of heating surface. But whereas No. 98 carries 200 lb. of steam pressure per square inch, "Albion" has no less than 228 lb., the same as "La France."

A Valuable Comparison.

This will enable an approximate test to be made of the long-vexed question whether the advantages claimed for compounding be in reality due to that method, or to the higher steam pressure employed by compound locomotives. I say "approximate," because as a matter of course the test could not be complete unless the two engines in comparison were identical, save in the one being compounded and the other not. As it is, the two engines differ in almost every respect save their steam pressure and the size of their coupled driving wheels, while of these latter the one engine has four, the other six. The cylinder treatment is curiously diverse, "Albion" having 18-in. cylinders, whereas "La France's" four cylinders would be approximately equivalent to two 22-in. cylinders were she a non-compound. On the other hand, while "La France's" cylinders are only 25¼ in. in length, those of "Albion" are no less than 30 in. long. So here are several points as to which account will have to be taken in comparing results.

A Second Alternative to Steam Dome.

While noticing Great Western novelties, I may mention one which so far does not seem to have attracted

the attention it deserves. Hitherto it has been generally accepted as an axiom that a locomotive must take its steam from the boiler in one of two ways. It must either be taken by the regulator from the upper part of a steam dome or else it may be collected through a perforated pipe along the top of the boiler. It has always been practically assumed that by no other means could the steam be obtained in a sufficiently dry condition. For many years the Great Western, like the Great Northern and South-Eastern, adhered to the domeless boiler with the perforated pipe. Then, as in the case of those other railways it "'verted" to the prevalent fashion of the steam dome. Latterly, it has once more *re*verted to the domeless boiler with the perforated pipe. But with the new so-called "taper" or "extended wagon-top" boilers, Mr. Churchward finds that he can adopt a third alternative, and take his steam from the highest point in the boiler in an amply dry state without the intervention either of the dome or of perforated pipe. The abandonment of the dome has become almost compulsory by the great height to which the latest Great Western boilers are raised; but its loss is not deemed a matter for regret, inasmuch as however ingeniously its fitting may be designed, the steam dome does necessarily and unavoidably weaken the barrel of the boiler. On the other hand, there have been deemed to be certain disadvantages attaching to the perforated pipe alternative. Thus, if the new and third alternative, namely, of dispensing with both, possessing as it does distinctly superior simplicity of method, proves to work with entire satisfaction in practice, another new departure, both valuable and interesting, will have been advantageously taken.

Water Troughs and Pick-up Scoops.

Water troughs are being laid down in the four-foot ways on the Great Western line near Starcross. This would seem to foreshadow some runs between Paddington and Plymouth without stop in the coming summer. The "new" Great Western—if I may use the expression—likes to keep well in front, and the long-vaunted "longest non-stopping run in the world"—viz., Paddington-Exeter, 193¾ miles—might at any time have its "nose put out of joint" by a rival. I am not now thinking of the London and North-Western's possibilities of London-Holyhead, 264 miles, or London-Carlisle, 299 miles. Those can be done, and have been, but it may be doubted whether they would be "practical politics" for daily use. The case of London-Plymouth is different. The relatively level road extends beyond Exeter to Newton Abbott, and it is only afterward that the severe grades come in; while the additional distance is not great. The London and North-Western, however, might at any time relegate the London-Exeter run to second place by running between Wigan and London without stop, instead of calling at Willesden, as at present. That would give a clear run of 194 miles, instead of 188½ to Willesden. At present the London and North-Western is a good second with 192½ miles, from Euston to Edge Hill, done by the American boat special. Euston-Wigan or Wigan-Euston would just turn the scale on that side. But Paddington-Plymouth, 245¾ miles, would clearly be an "easy first." The more one realises the advantages conferred by the ability to pick up water at speed, the more one marvels at the slowness of its adoption.

When the London express is delivered by the London and North-Western at Carlisle and taken on by the Caledonian, fifty-five ton tenders succeed those of twenty-five tons previously used. These mean excessive haulage of dead weight, especially when two engines are used. Yet there are level stretches on the Caledonian where troughs could be laid, as there are also on the London and South-Western, which, like the Caledonian, still dispenses with this and drags about huge eight-wheeled tenders. It is somewhat curious that while such strenuous efforts are being made—and very properly—to augment the power exercisable per engine, the excess of dead weight needlessly hauled seems to be regarded with indifference. Yet obviously if the dead weight could be diminished by 10 per cent., the relative efficiency of each engine would *ipso facto* be proportionately augmented, and practically nine locomotives would do the work of ten. This, no doubt, is, like many other desirable things, "more easily said than done," but when larger tenders add a further sixty tons of dead weight to a 400-ton train, and when four huge dining cars of an aggregate weight of more than 160 tons are hauled needlessly some seventy-three miles, over a summit of 1,080 ft. high, after their necessity has ceased to exist, one cannot help reflecting on the possibility of affording some relief in this direction to over-burdened locomotives—and *share-holders*.

Compounds and Compounds.

Extreme as has been the slowness with which the compound principle as applied to locomotives has come into use in Britain since its modern initiation by Mr. F. W. Webb in 1882, there at last are symptoms—if one may judge from appearances—that the principle is to receive a more extended trial henceforth than it has enjoyed hitherto. So far it must be admitted that the London and North-Western Railway and its late chief mechanical engineer have enjoyed an honourable, if regrettable, solitude as regards the compound crusade. Mr. Webb built his first compound locomotive just twenty-one years ago, completed at a cost not far short of £100,000, a first batch numbering thirty of the same type and class which, as express engines, have been unsuccessful—to put the case very mildly indeed—and then constructed four successive batches of forty, ten, ten and ten of express locomotives on the same principle but of different dimensions, all having three cylinders the first three of these batches proving distinctly efficient and useful. He also built a number of eight-coupled goods engines to his three-cylinder compound design. Then he suddenly and absolutely abandoned that design and brought out instead a four-cylinder system, differing in virtually every respect from its predecessor. It is now represented by eighty large express engines and a number of eight-coupled goods locomotives. That practically sums up the history of locomotive compounding on the only British railway that has systematically carried it out during a long term of years. The various sporadic experiments with different types of compound tank engines may be neglected as not germane to the real inwardness of the present subject. At the present moment there has been reached, through the retirement of Mr. Webb and the appointment of his successor, a break in the continuity of the compound chain. That is to say it is not yet known authoritatively outside the secret places of the Crewe offices whether the London and North-Western express locomotive at any rate of the future, is to be compound or non compound, and if the former whether of the four-cylinder or the three-cylinder type.

ELECTRICAL AFFAIRS.

BY

E. KILBURN SCOTT, M.I.E.E., A.M.Inst.C.E.

The Report on the Bristol Fire.

Mr. Faraday Proctor's report on the causes of the Bristol fire has been presented and the conclusion come to is that it is traceable to one or other of the following causes:—

(1) By static discharge from the metal work of the board charged at high pressure, over the surface of the insulators and slate to "earth," or in other words, to the other pole of the board, in which case it is further possible that this may have been in a measure caused by an invisible crack in one of the insulators.

(2) By the breakdown of a joint-box wherein the cables from the machines or mains are connected to the switchboard.

(3) By the abnormal action of one of the machine fuses, the blowing of the fuse causing an arc and breaking the porcelain pot filled with oil in which the fuse is placed.

To the writer's mind the last is the most likely cause, and, at any rate, it is very certain that when once the fault commenced the spreading of the trouble was *mainly due to the oil*. A further trouble was, of course, the burning of the impregnated jute insulation on the cables connected up to the switchboard. It may be asked why was not the supply cut off from the Avonbank Station; this, it appears from the engineer's report, was due to the fact that all the private telephones were rendered useless by induction on the wires.

The Use of Oil for Electrical Apparatus.

The suppressing of arcing at switch and fuses contacts, etc., by immersing in an oil bath is all very well, but if there is any lesson to be learned from the Bristol fire it is that the employment of such an inflammable substance as oil on a switchboard is most unwise. As a matter of fact the old idea that the arcing on opening a circuit should be instantaneously suppressed is dying out. On the Continent most high-tension switches and many fuses are fitted with flaring horns similar to the Siemens and Halske lightening arrester, and the arc puts itself out by reason of the convection air-currents started by its own high temperature.

High-tension transformers are another piece of apparatus for which oil is often used; and if there should be an accident and the oil catch alight the results might be much worse than the mere burning out of one transformer. There is no doubt that when properly prepared oil is an excellent insulator, and that it tends to automatically heal up small faults, but this characteristic may be bought at too high a risk. Here, again, the writer is of opinion that oil is out of place, and that large transformers should be cooled by forcing dry air through the casing and between the coils and core, etc.

Importance of Not Suppressing an Arc too Suddenly.

To show the change which has taken place in engineers' opinions on the question of suppressing arcs the series parallel controller may be instanced. A few years ago anyone suggesting that these should be made without a magnetic blow-out would have been thought behind the times, and yet the tendency is now to *dispense with the blow-out*. Many of the cars at Glasgow, for example, have been running with ordinary type controllers for a considerable time. The bad effect of too suddenly suppressing an arc was well shown when the magnetic blow-out was first introduced into this country. It was found that English-built motors, which had worked well with ordinary controllers broke down badly when coupled to controllers having magnetic blow-outs. In order to withstand the additional stress, the insulation of the field coils had to be very considerably increased, the test pressure being over six times the working pressure.

Increase in Charges for Electricity at Cheltenham.

It is seldom that one hears of a town raising its price for electricity, and it comes, therefore, as somewhat of a surprise to find that Cheltenham finds the existing scale of charges unremunerative. Thus public lighting is to be increased from 1·91d. to 3d. and for private consumers from 5½d. to 6d. up to the equivalent of 500 hours' use per annum of the maximum demand recorded by the demand indicator; 2d. per unit being charged for all consumption during the year beyond this. The Light Railway Company is also to be notified of an increase, the present charge of 1·9d. per unit being unremunerative. There is undoubtedly much unrecorded history behind this statement, and it would be of great benefit to the community to have all the facts of the case made public. As things go throughout the country they are high, especially the 1·9d. per unit for traction.

Scientific Ladies.

Ladies are every day taking a greater part in scientific affairs, and there can be no doubt that for research work; many have shown undoubted ability. Mrs. Ayrton's name will occur to everyone in connection with arc-lamp phenomena, and in radium research Madam Curie and Lady Huggins have done much towards probing this most interesting mystery.

As a rule the ladies keep to the purely scientific side, but it may be news to many that Mr. B. J. Lamene, the prolific inventor of the Westinghouse Company at Pittsburg, is most ably assisted by Miss Lamene. If all the writer has heard of this lady is true she can set about a complicated winding diagram or a series of calculations for a dynamo with the best of the Westinghouse staff.

POWER STATION NOTES.

By E. K. S

The Smoke Nuisance.

One action of the municipal authorities with which practically everybody is in sympathy is the attempt which they are making to stop the reeking of smoke from chimney stacks. Electric stations have never, at their worst, been half so bad as factories, iron works, etc., but owing to the fact that electric stations must, of necessity, be built in cathedral cities, seaside towns and other show places, the matter assumes additional importance in connection with them.

Of course smokeless Welsh coal can be used, but the price is so high, compared with the various slacks which are available, that the temptation to use cheaper coal is great. Especially is this so as the coal item generally decides whether a power station will pay its way or make a loss. In large stations where mechanical stokers are employed the regularity of firing in small quantities reduces the tendency to smoky chimneys. It is in hand-fired boilers that the smoke preventer is most urgently wanted.

Smoke Preventers.

It may be interesting to briefly describe two methods of smoke preventers which have recently come before the writer's notice. The first, which has been fitted to the Babcock and Wilcox boilers in the Bath tramways station, is the invention of Mr. Appleyard, and merely consists of a small steam jet in each furnace, which the stoker turns on each time he opens the furnace door. There is, of course, a possibility of the stoker forgetting to do this, but it would be easy to attach a lever from the furnace door to the steam cock, so that it opened and closed automatically.

The other method is quite a novel departure, in that it involves the addition of a gas generator. It is being placed on the market by the Welskemp Smoke Consumer Syndicate and has already had a successful trial at Hornsey. The gas is produced from anthracite peas in a small water-sealed generator, a mixture of air and steam being forced through the incandescent fuel in the usual way. The gas is delivered into a pipe having 3 in. branches which pass underneath the fire-bars to a bridge at the back of the furnace. At this point a combustion-chamber or regenerator is built up of fire bricks, laid together without fire-clay and arranged in zigzag fashion. The furnace gases have thus to pass through a series of brick chambers heated by the gas flume from the 3 in. pipes, and there is no possible chance of black smoke issuing from the chimney.

The Underfeed Stoker.

The question of mechanical stoking follows naturally on the above subject of smoke prevention, for a good stoker is in itself a smoke preventer. Amongst the more recent types the underfeed stoker appears to promise very well. In this type a steam-driven ram pushes the coal forward at regulated intervals of one to three minutes into a trough-shaped fire-grate, and unlike most stokers the new coal *rises up from underneath*. Air enters the furnace from a series of tuyere blocks along each side of the trough, above the fresh coal but below the fire. It is therefore thoroughly mixed with the gases which are liberated in coking the fresh coal, and the result is practically smokeless combustion even with the cheapest slack. The non-combustible clinker falls on to dead plates which run down each side of the trough, and it is removed by hand at suitable intervals.

Steel-Plate Boiler Flues.

The new electric power station at Oldham is somewhat curiously arranged in that there are three rows of boilers, the outside rows being dry back marine and the centre row a new type of boiler, the Climax. The flues for the marine boilers are arranged underground in the usual way, but the flue for the Climax boilers runs along inside the apex of the boiler-house roof, about 40 feet above floor level. It consists of a steel tube 10 ft. in diameter.

In the States, steel flues are much used, thus the power house of the Lexington and Boston Electric Railway has the flue made of steel $\frac{3}{16}$ in. thick.

At the Central Electric Supply Co.'s works at Grove Road, Marylebone, 14 Climax boilers are in use, and the flue runs along the tops of the boilers and enters the chimney at the level of the boiler-house roof. The flue is constructed of double plates, with an air space of about three inches between them.

IRON AND STEEL NOTES.

By E. H. B.

The Midland Wages Board.

Sir Benjamin Hingley, presiding at the annual meeting of the Midland Iron and Steel Wages' Board, said that, although trade had been dwindling throughout the year, ironworkers' wages continued unaltered. He saw no prospect of improvement, and no apparent lift in the clouds. They had all sorts of fiscal proposals, but he recommended industry, economy, and avoidance of waste.

Statistical Memorandum of the Tariff Commission.

From Mr. W. A. S. Hewins, Secretary to the Tariff Commission, I have received a memorandum and statistical tables respecting the iron and steel trades. These should be in the hands of all who are interested in British iron and steel. They are designed to focus attention on the industry as a whole, and not upon any part of it, however great. The inquiry has been divided into three main divisions :—

1. The analysis of official returns, British and foreign, bearing upon the conditions of industry here and in other countries.

2. The issue of forms of inquiry to the various trades in which questions are included to elicit information supplementary to that contained in returns already available.

3. The examination of representative witnesses from each leading trade with a view of testing the accuracy of the conclusions indicated by the two foregoing methods.

Inquiry forms thus far issued by the Commission have met with a generous response from manufacturers representing every shade of opinion on the fiscal question, and many thousands of replies have already come in. The first step upon receipt of these replies is to number the forms and provide for the absolute secrecy of the source of information where secrecy is desired. Only in a very small proportion of cases, however, do those replying to the inquiries wish their names withheld. It is announced that the examination of witnesses will shortly be commenced.

Styrian Steel.

An instructive lecture on Styrian steel was given by Mr. R. B. Hodgson at a recent meeting of the Birmingham Association of Mechanical Engineers. As far as Britain is concerned, the author showed that the primitive inhabitants of these islands were acquainted with iron, but the Romans taught the Briton how to treat and fashion the metal properly, and numerous ironworks sprang up in the Forest of Dean, Bath, Yorkshire, Cardiff, and other places. On the withdrawal of the Roman legions iron smelting languished for several years, and it was not until the sixteenth century that it revived. In 1581, so great was the consumption of timber for smelting that an Act was passed restricting its use within a radius of twenty miles of London, whilst in the twenty-seventh year of Elizabeth's reign an Act for the preservation of timber in Sussex, Surrey, and Kent was passed. Smelting iron by the aid of coal was not successfully accomplished until the early part of the seventh century, whilst coke was introduced one hundred years later. The lecturer then proceeded to trace the history of Styrian steel, showing the interesting link connecting the extensive works of Bohler Brothers at Styria with the remote past.

The Value of Microstructures.

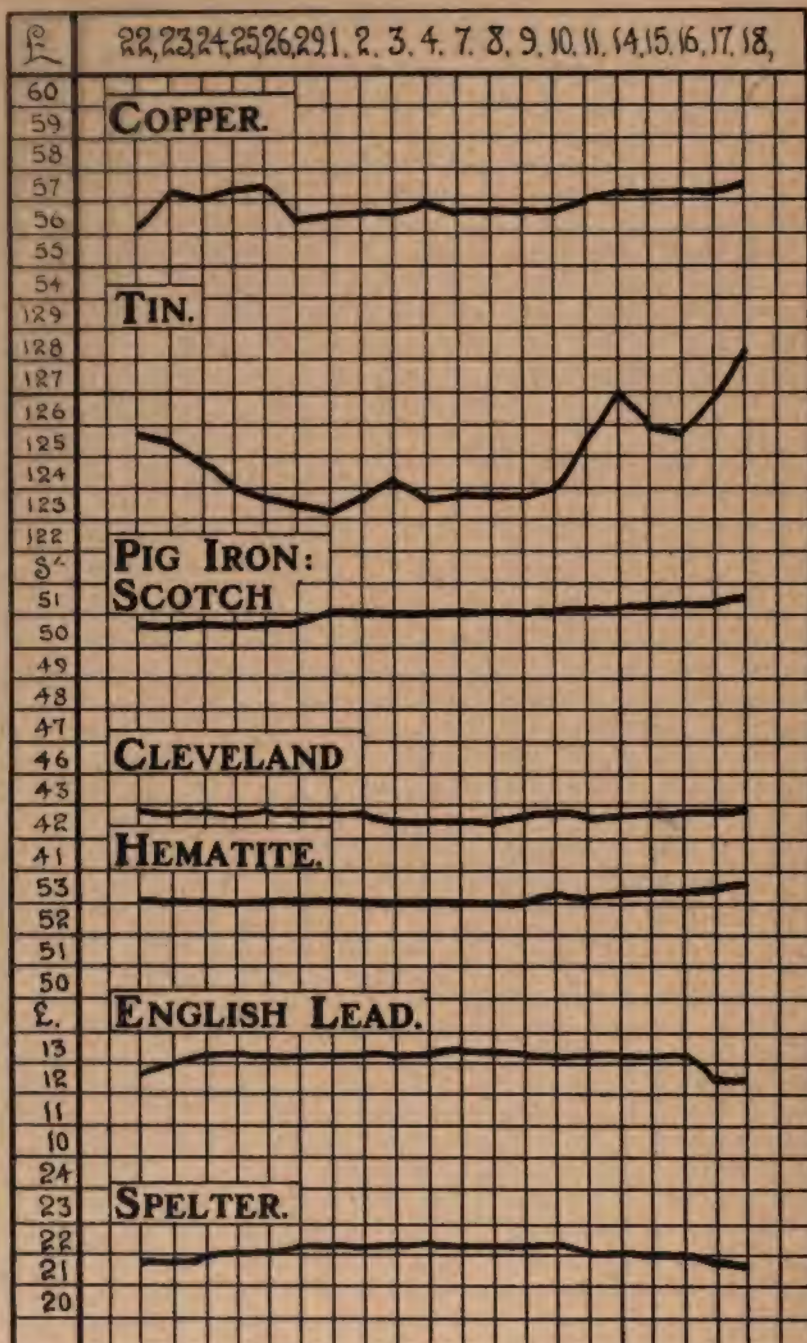
How far does a small section such as is used for microscopic examination, represent the structure of a mass of steel ? We are so accustomed to microphotographs of steel in these days that one is apt to take them for granted. The question, however, is one of the first which is suggested to the engineer and metallographer and in a paper recently read before the West of Scotland Iron and Steel Institute, Messrs. A. Campion, F.I.C., F.C.S., and H. W. Watts, present a collection of notes which should be of assistance in clearing up this point. Mr. Walter Dixon stated the difficulty clearly in the course of discussion several years ago, when he raised the question in the following terms :—

"In considering such a subject, there always appeared to him one great difficulty. Perhaps it was an illusionary one, and if so, he should like to be rid of it. If the metals under consideration were perfectly homogeneous, *i.e.*, of exactly the same structure throughout, it is obvious that a section, however small, or however large, taken from any part of the mass, would under the microscope show identically the same structure ; and the results so revealed by the microscope would be invaluable. Was it not, however, a fact that the metals so dealt with were, especially when microscopically considered, essentially of a heterogeneous nature, and that it might be impossible to take two sections from any one piece of metal which would show under the microscope identically the same structure ? He stated that when he considered the subject he could never get out of his mind an example which might be taken from one of our coarser granites or marbles, which perhaps, in an exaggerated form, might represent the metals under discussion. From a cubic inch of many of these stones it would be possible to obtain hundreds of sections, not any two of which would be microscopically alike."

The author's investigations show very plainly that in the case of sections of steel of small mass and regular shape, the structure, as exhibited by the microscope, discloses but little variation at different parts of the piece, provided it has been subjected to the same treatment throughout. Round bars of large diameter of rolled material, and forged material for axles and spindles may exhibit considerable differences of structure between the outside and central portions. The differences, however, are (excepting in cases where the material has been specially treated) very little if any greater than those obtained in analytical and mechanical testing. Material in irregular shapes and unequal masses exhibit very considerable differences as regard both analyses and structures in the various portions of the section.

Such materials as axles and tubes of guns, which have been subjected to special treatment, as oil quenching and tempering, show the effects of the treatment in a marked degree on the outside portions. The carbide areas gradually diminishing in volume towards the centre where the structure (except in material of very small diameter) exhibits that of the material before treatment.

Although a large number of etching media have been suggested by various operators ; and everyone has his own pet solution, they all give identical results when used under suitable conditions. The structure of some steels may be much more clearly developed by one method than another ; but the ultimate result, as far as size of grain and constituents present, is the same in all cases.



THE HOME METAL MARKET.

Chart showing daily fluctuations between February 22nd and March 18th, 1904.

AUTOMOBILE NOTES.

In the course of a paper contributed to the Engineering Society of Glasgow University, Mr. J. E. Thorneycroft calculated that on the average, horse haulage cost 8d. a ton per mile, while the cost of motor haulage was 2½d.

The Commission du Yachting Automobile has fixed the date of its motor boat race for 1904, which will take place on Monday, August 8th, about 10 o'clock in the morning, starting from either Calais or Boulogne and finishing at Dover.

Prominent at the interesting Automobile Exhibition at the Agricultural Hall was an ingenious six-ton tip wagon with telescopic lifting gear by the Lancashire Steam Motor Company, Ltd. Other vehicles for trade purposes were shown by Messrs. Foden, Ltd., of Sandbach; the Yorkshire Patent Steam Wagon Company, Messrs. J. Robertson and Son, of Fleetwood, the Hercules Motor Wagon Company, the Empire Hagen Motor Wagon Company, Messrs. J. and F. Howard, Mann's Patent Steam Cart and Wagon Company, Ltd., Wallis and Stevens, Ltd., and Savage Brothers, Ltd.

The first of the North-Eastern Railway motor coaches, after preliminary tests, went through a very satisfactory official test run of 60 miles on their main line. This coach was fitted with the first of the new "Wolseley" 80 b.h.p. petrol motors, constructed by the Wolseley Tool and Motor Car Company, Ltd., Birmingham. The petrol consumption was approximately one pint per b.h.p. hour. A speed of nearly 40 miles per hour was frequently attained, and the 60 miles test run was accomplished at about 30 miles per hour average speed, including four stops and starts. The coach climbed a bank 1 in 95 on each journey. Its weight is about 35 tons.

At the annual general meeting of the Automobile Club, held at the Institute of Mechanical Engineers, Westminster, Mr. Roger Wallace presided over a large gathering of members. Lord Shrewsbury moved: "That no member of the Automobile Club in the trade, or journalist connected with an automobile journal, be eligible for membership of the club committee." As an amendment Mr. Jarrott moved, "That as the club is primarily a society of encouragement, any attempt to secure that the trade section should not be represented would be unjust, unconstitutional, and fraught with danger." Mr. Jarrott's amendment was carried by a large majority.

The following entries have been received for the Side-slip Competition, which is to be held at the beginning of April, under the auspices of the Automobile Club: Mr. Mark Vivian (Chiswick), the Wilkinson Tyre and Tread Company (Huddersfield), The Continental Caoutchouc and Gutta Percha Company (London), Mr. Alexander Nicholson (Dublin) (2 cars), Commander Charles T. Scott (Sheffield), Rourke and Horsburgh (Bromley), Sainsbury's Anti-Skidders, Ltd. (London), Mr. Henry S. H. Cavendish (London), Mr. E. Midgely (London), Mr. Wm. Hunt (Kettering), Mr. Samuel Butler (Westbury-on-Trym), Mr. W. Maitland Edwards (London), Mr. Henri David (Paris), Grose, Ltd. (Northampton), Mr. John Harrington (Brighton), Parsons Non-Skid Company (London), Wm. Jenkinson and Co. (London).

As we go to press we are informed by the technical secretary of the Automobile Club that it has been decided that their Side-slip Competition shall commence by an endurance test of 1,000 miles, to be carried out in five or six days, starting from the Automobile Club at 9.30 on Monday, April 18th. On the completion of the 1,000 miles' run the cars will be submitted to the side-slipping tests, which will be carried out on the track round the new works of Messrs. Clement Talbot, near Ladbrooke Grove. The track is wood pavement, which will be made greasy, and the cars will have to make a right-angle turn on the grease, to describe "S" curves, and also to be subjected to brake tests. The power absorbed by the device will be tested by running the car down-hill by gravity both with and without the device fitted, and measuring the distance between the stopping places in each case.

Points will be given for ease of attachment and renewal and for price, and a device which gives the best control of the car under all possible conditions, that is to say, whether for side-slipping of front or back wheels, or of forward skidding, will be considered the better.

Eighteen cars will actually take part, and each of these will carry an honorary observer throughout the whole of the 1,000 miles to see that nothing is done to the device. We note that a number of observers are still required.

Discussing points about the 1904 motor bicycle, in which there is room for improvement, Mr. B. H. Davies, in the "Motor Cycle," recently remarked:—

"Bowden wires, in my experience, are either badly fitted by the majority of workmen, or are not made of sufficient strength; the makers say the former, of course, but I should be better pleased if the strands had a margin of strength to allow for unskilled fitting. Most of the modern silencers belie their name; the rider does not notice the noise, but other road users do. Carburetters should be made dustproof. Oil tanks and connections are often carelessly finished; every new machine I have had has leaked oil fiercely, and in each case the cure has been simple, showing the fault to be unnecessary. Two accumulators are a great advantage. The rear horseshoe brakes are inaccessible on one or two machines, and are not substantial on any. On two occasions mine has fouled the valve and ripped out spokes, on one occasion buckling the wheel so that further progress was impossible. Handle-bar control of *all* the operations is not necessary. I prefer to have a switch and exhaust lifter on the handle-bar, and long levers on sectors screwed on the top tube, for throttle, air, and spark. Stronger free-wheels and protectors for them are a crying need. Every clutch I have owned has gone sooner or later. Increased petrol capacity ends my list of desiderata, as the chief of all is a practical impossibility, *i.e.*, detachability of the engine." In spite of all this, Mr. Davies strongly emphasises the fact that the 1904 motor bicycle may be relied upon to "get there."

AMERICAN RÉSUMÉ.

By Our New York Correspondent.

NEW YORK, March 19th, 1904.

The Man and the Lamp.

The annual dinner of the American Institute of Electrical Engineers was an event of more than ordinary importance by reason of the tribute paid to the genius of Thomas Alva Edison, whose fifty-seventh birthday synchronised with the event. The organisers with a fertility of enterprise worthy of the occasion, also arranged that the dinner should represent the twenty-fifth anniversary of the practical perfection and commercial introduction of the incandescent lamp, while at the same time the Edison Medal, founded for research in theoretical or applied electricity or magnetism, was also inaugurated.

Congratulations poured in from all parts of the world, including a tribute from the President of the British Institution of Electrical Engineers. From President Roosevelt came the message: "I congratulate you as one of the Americans to whom America owes much; as one of the men whose life work has tended to give America no small portion of its present position in the international world." Mr. Carnegie did not hesitate to subscribe himself as Liegeman to King Edison I. The post prandial proceedings were of the happiest character.

Mr. T. C. Martin gave Mr. Edison's health in the following terms:—

"The American Institute of Electrical Engineers is proud to embrace in its membership to-day the foremost inventors of the age and the greatest captains of industry, and has placed upon its golden tablets many an auspicious discovery and art to celebrate. But it surely could find no worthier hero among them and no better gift to mankind to signalise than the man and the lamp around both of whom we twine to-night the laurel wreaths of our admiration and our love.

"There should be encouragement in the founding of this medal to-night for every struggling, ambitious youth in America. Let us and let our sons recall and applaud the cheery little newsboy at Detroit, the half-shod, half-frozen operator seeking bravely a job along the icy spikes of the Central States; the gaunt, untutored experimenter in Boston, taking eagerly needed fees for lectures he was too modest to deliver; the embryonic inventor in New York, grubstaked by a famous Wall Street man for his first stock ticker; the deaf investigator at Menlo Park, who wreaked unique retaliation on his affliction by preserving human speech for ever with his phonograph; the prolific patentee who kept the pathway to the Patent Office hot with his footsteps for nearly forty years; the genius, our comrade, who took this little crystal bulb in his Promethean hand and with it helped to give to the world a glorious new light which never was before on land or sea—Thomas Alva Edison."

Edison's Reply.

Edison's telegraphed his speech to the assembled guests as follows:—

I want to thank first of all my fellow-members of the American Institute of Electrical Engineers for the great honour done me in thus celebrating my birthday, associated with the twenty-fifth anniversary of the completed development and successful introduction of the incandescent lamp. Your expressions of good-will gratify me deeply. While I cannot but rejoice at the place which the incandescent lighting art has made for itself among the inestimable comforts and conveniences of civilisation, I feel that my share in the work is exaggerated by this prominence given me to-night.

To my old friends and associates who have founded the Edison Medal in the Institute—I can but extend you thanks again. If I could do it in return, I would found a medal for every one of you, for you are just as much entitled to recognition as I am. You gave me your friendship and loyalty, your watchful days of toil and sleepless nights of anxiety. Some of you helped to perfect the art by your engineering skill, your legal ability, your financial aid.

The early days were enough to tire out any one's courage and persistence, but you stood it all, and put up with me into the bargain. Now, in noble revenge for the burdens I put on you, and in addition to all the evidences of friendship in the past, you add this unusual token of continued affection. I should not be human if I were not profoundly affected and deeply grateful.

This medal is founded to encourage young men to devote their best thought and work to electrical development. I rejoice in this stimulus to harder study. Better trained and educated than were we men pioneers of the times before every college and university had its electrical course, these coming men of the future should, and I believe will, carry forward to triumphs and arts heretofore undreamed of, the principles and applications of electricity to which I have tried humbly to devote my life and energies from the hour my hand first touched the key. God bless them, and you, my dear friends, and this American Institute of Electrical Engineers.

The Westinghouse Single-phase System on the Indianapolis and Connersville (U.S.A.) Railway.

The Westinghouse Electric and Manufacturing Company, of Pittsburg, have undertaken the equipment of two long inter-urban railways in the United States on their new single-phase system. One of these is the Fort Wayne, Decatur and Springfield road, which extends from Fort Wayne (Ind.) to Springfield (Ohio), a distance of about 110 miles; the other a high-speed line 53 miles long is to run from Indianapolis to Connersville (Ind.), but will eventually be extended to Hamilton, a total distance of 93 miles.

As showing the adaptability for single-phase working of present types of generating plant, it may be mentioned that it was first decided to work the Indianapolis and Connersville line on the direct-current system; but the single-phase system was adopted on account of its lower first cost and running expenses. Although two 500-kilowatt high-voltage three phase generators had been placed on order for the direct-current working of the line through rotary converters, it was not found necessary to do away with these, the power station

equipment, so far as the engines and generators are concerned, remaining as first laid out. The generators will develop a pressure of 2,300 volts, and this pressure will be stepped-up to 16,500 volts two-phase for transmission on the Scott system to the six static transforming sub-stations, which will be located every ten miles or so along the line. Half of these stations will be connected on one phase and half on the other, and the supply will be reduced to a trolley voltage of 3,300, transformers on the cars bringing this pressure down to the working level. The trolley wire will be No. 000 B and S gauge copper. Induction control (*i.e.*, by means of a rotatable core transformer) will be adopted on the Fort Wayne and Springfield road; and rheostatic control on the Indianapolis-Connersville line, the car equipments of the latter having to be worked with direct-current within the confines of Indianapolis City. The first ten cars ordered will be each equipped with four 75-h.p. motors, so geared as to develop a speed of 42 miles per hour on the level. The consulting engineers estimate that the adoption of the single-phase in place of the direct-current system will result in a saving of £100,000 on the whole line from Indianapolis through Connersville to Hamilton.

These two lines will be the first in the world to be equipped upon the single-phase system, and their completion and working will doubtless be looked forward to with great interest by English railway engineers.

The Late Senator Hanna.

The late Senator Marcus A. Hanna, although chiefly known to fame as a politician, did not enter the political arena until he had attained ripe experience as a business man. From 1857 to 1867 he was connected with the oil trade, but in the latter year he transferred his attention to iron and coal, becoming senior partner of the firm of Rhodes and Co., who were heavy dealers in coal and iron, their coal mines being in Tuscarawas county. This firm, dissolved in 1885, was succeeded by that of M. A. Hanna and Co., which consisted of M. A. Hanna, L. C. Hanna and A. C. Saunders. Senator Hanna proved himself a born organiser, and in the negotiation of innumerable business propositions proved himself a capable leader of men. One of his most notable characteristics was his successful method of settling controversies with his employees. He took a pride in saying that he never had any serious labour trouble. A business associate who was asked for his ideas as to the secret of Mr. Hanna's success in business, said: "First, I would place his rare good judgment. He seldom erred. He also had great ability in looking into the future and foreseeing the course of events. His capacity for work seemed to be unlimited and his energy was untiring. Another characteristic, which contributed to his success, was his faith in men whom he believed to be honest. When once convinced that a man was honest, there was nothing in his power that Marcus A. Hanna would not do for him. More men than the public has any idea of were helped along in the battle of life by Mr. Hanna. Sometimes when a man had made grievous mistakes and had been rejected and even branded as dishonest by former associates, Mr. Hanna, if his confidence remained unshaken, would still freely extend a helping hand. In all of his long business career there was never the slightest hint that he was guilty of anything inconsistent with the highest integrity. One cannot say that he ever was tempted to do anything dishonest. He simply would not consider anything of the kind. His policy was always one of frankness and honour. Although he had many friends among men high in the political world, he will be mourned by none more deeply than by the wage earners on docks and vessels, in mines and at furnaces, who, by coming in contact with him, grew to love him."

Baldwin Locomotive Works.

Some time ago, in PAGE'S MAGAZINE, a series of articles by Mr. Joseph Horner on the Laying-Out of Workshops, called attention to the difficulties of engineers in providing for the necessary expansion of their works. Improvements have recently been made at the Baldwin Locomotive Works which show that limitations of space surface need not be an insuperable bar to expansion. The first thing to be done was to remove all heavy hammers to the Standard Steel Works at Burnham, Pa. All heavy castings are also made at the same place, besides most of them for light work. This change of location of heavy work relieves the pressure and allows the erection of a boiler shop on the second storey over the old foundry, and the erection of a blacksmith's shop for light work, besides a frame drilling and fitting-up shop on second floor over the old blacksmith's shop, and the work of fitting up throttle valves, stand pipes, dry pipes and piston valves on the second floor over the old cylinder shop. These examples of an effort to be freed of entanglements due to lack of ground area, have worked out most satisfactorily, and are giving results looked for in an increased output. Another large factor to this end was the installation of the plant at 26th Street, to be used exclusively in the final application of fittings, an engine and tender, prior to shipping from the works.

The Panama Canal.

The American Chamber of Commerce Bulletin remarks that with only fourteen votes in opposition, the United States Senate on February 23rd ratified the Panama Canal treaty, and early construction operations are now assured. Many important American commercial interests have already laid their plans for reaping practical advantage from the new waterway. The New Orleans Board of Trade, the chief business body of the Southern metropolis of the United States, has given its indorsement to a project to build a line of steamships to pass through the canal and trade with the Western countries of South America and with Asia. The plan is to build a fleet of large, swift, modern vessels, to interest the entire Mississippi Valley in the project, to raise $5,000,000 for the work, and to get the Governors of the States in the valley, the mayors of the cities and all its commercial bodies to take a hand in the scheme by way of subscribing for the stock or receiving subscriptions.

Allis-Chalmers Developments.

It is announced that the Allis-Chalmers Company is about to engage in new lines of manufacture, namely, steam turbines, hydraulic machinery, gas engines and electrical machinery.

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SOUTH AFRICAN RÉSUMÉ.

By Our Johannesburg Correspondent.

JOHANNESBURG, March 11th, 1904.

Rhodesian Mineral Output.

The following are the official figures for the year 1903, published in the report of the Rhodesia Chamber of Mines:—

	Gold.		Silver.	Lead.
	Ozs.	Dwts.	Ozs.	Tons.
January	16,244	11·29	—	—
February	17,089	13·83	—	—
March	19,626	5·95	—	—
April	20,728	1·31	—	—
May	22,137	9·11	—	—
June	22,160	8·35	—	—
July	23,370	15·21	—	—
August	19,186	14·31	—	—
September	18,740	13·27	4,160	19·50
October	17,917	13·87	4,281	27·30
November	15,713	16·25	4,757	49·56
December	18,750	2·21	2,573	31·60
	231,872	4·96	15,771	127·96

The next table shows the progress that has been in the output of gold:—

	Ozs.	Dwts.
Output prior to December 31st, 1898	24,555	13
Output for year 1899	65,303	13
Output for year 1900	91,940	8
Output for year 1901	172,061	8·75
Output for year 1902	194,169	6·23

A Geological Discussion.

During the present dull season, the mining experts are finding occupation for themselves in discussing the origin and nature of some of the strata of the main reef series, and more particularly with that layer of rock which has been known as the "Hospital Hill shales," because it was considered by everyone to be of sedimentary origin.

Mr. G. A. Denny, consulting engineer to Messrs. Albu, has, however, recently declared this rock to be of igneous origin, and he submits, as evidence of his contention, a number of hand samples, and also microscope sections and chemical analyses. But Dr. Hatch and Mr. Dorffel, who uphold the accepted view as to the origin of these rocks, not only disagree with Mr. Denny's conclusions, but challenge his evidence in detail.

The opposing statements given in parallel columns below will show how very fundamentally even experts may differ, and they also suggest the desirability of referring the disputed sections and samples to some school of mines or other authority whose views are not influenced by any local considerations or previous correlations of reefs.

Petrological Divergencies.

Mr. Denny's microscopical determinations.	Dr. Hatch's determinations of same slides.
Nos. 73 and 80. Dolerite.	Distinct quartzitic slate.
No. 76. Dolerite.	Quartzitic slate is full of quartz fragments.
No. 155. Footwall dyke.	Quartzitic slate full of quartz fragments.
No. 169. Granular dolerite.	Beautiful example of fine grained quartzite.
No. 170a. Porphyritic dolerite with zonal structure induced by weathering.	Quartzitic slate, with banded structure due to variations in size of quartz fragments.
Nos. 219, 220, and 221. Porphyritic dolerite with felspar and olivine.	Quartzitic slate with fragments of quartz and much dusty interstitial matter.
No. 222. Holocrystalline dolerite.	Quartzitic slate with fragments of quartz, etc.
Nos. 244, 245, and 273. Holocrystalline dolerite.	Quartzitic slate with many quartz grains in dusty matter.

Differences of Opinion.

Mr. Denny says:—

"This rock" (from the Bird Reef) "is pronounced by Messrs. Hatch and Molengraaf to be slate and the Hospital Hill 'shales' are also stated to be slates, but the microscope, supported by the field evidence, abundantly and conclusively proves that the rock" (the rock from the Bird reef is here referred to) "is eminently crystalline and of eruptive origin. If, therefore, individuals of acknowledged authority on geological subjects can, by adopting locally accepted theories, so confuse the fundamental classification of rocks as to detect no difference in a slate and an intrusive rock, it cannot be expected that unscientific observers will be able to discriminate between them, and if this rock has been called a slate merely because it has a somewhat shaly structure, it can be understood how it is that the structure of the Hospital 'shales' has been universally accepted as an incontestable proof of their sedimentary origin.

Dr. Hatch says:—

"After this examination of Mr. Denny's sections I have not the slightest hesitation in stating my opinion that Mr. Denny's igneous theory of the Hospital Hill shales is founded on an incorrect determination. I am convinced that the true character of these shales will be recognised at once by all petrologists who will take the trouble to examine thin sections of them under the microscope."

Chemical Divergencies.

Mr. Denny says:—

1. The percentage of silica is far below the average of a typical slate or shale, and is in cases less than half that required as an essential constituent in fine-grained quartzite.

Mr. Dorffel says:—

1. The percentage of silica is not below the average of a typical slate.

2. That practically no quartz is to be seen in the ground mass.

3. The percentage of basic oxide is excessive, and unlike any slate or shale, and quite impossible in a fine grained quartzite.

4. That the rocks differ essentially from typical slates or shales or fine-grained quartzites in microscopic features since no granular structure can be recognised.

5. That crystals of felspar, augite, olivine, etc., can be recognised, but not always individualised in the less decomposed specimens.

6. That they are truly eruptive rocks.

2. The ground mass consists largely of quartz.

3. The percentage of iron oxides is not excessive, but is characteristic of this type of ferrugenous slates.

4. This rock closely resembles other well-known slates, and the structure is in many cases distinctly granular.

5. Fragments of felspar and augites may be present without proving igneous character, but I have not seen any. Olivine in no case is, and cannot be present.

6. It is difficult to see how rocks with the above-mentioned characteristics can by any stretch of the imagination be described as eruptive rocks.

The Outlook at Johannesburg.

The depression continues unabated. Even the building trade is now suffering, as the reduction of population has been proceeding at the same time that houses have been built in all directions round the town by those who, during the squeeze of twelve months ago, could not find accommodation. Although rents have come down a little, they are yet high, and it would still pay to build houses rather than to rent them, but owing to scarcity of money and the uncertainty of the next few months, few people have the money, and fewer still the courage to invest in residential buildings.

To one who lived through the Johannesburg slump of 1889–90, and experienced the rapid recovery which took place, there is nothing permanently disheartening in the present state of things, but it is not surprising that many newcomers have not been able to hold out, and have returned to their "place of origin."

And although certain of the ultimate triumph of the mining industry over its many difficulties, of which the chief one, of course, is the scarcity of labour, it is impossible to guess how long the present conditions may last. In the meantime this is a place to be avoided by all but confirmed optimists of independent means.

COMING EVENTS—APRIL.

2nd.—Birmingham Association of Mechanical Engineers: Paper on "Gas Measurement." Staffordshire Iron and Steel Institute, the Institute, Dudley, at 7 p.m.

7th.—Civil and Mechanical Engineers Society, Caxton Hall at 8 p.m. Liverpool Engineering Society, Royal Institution.

9th.—The Manchester Association of Engineers. Birmingham Association of Mechanical Engineers: Visit to the Oldbury Gas Works. North of England Institute of Mining and Mechanical Engineers, Newcastle-on-Tyne, at 2 p.m.

11th.—Society of Engineers, the Royal United Service Institution, at 7.30 p.m. The Institute of Marine Engineers, Stratford, E.

12th.—Institute of Civil Engineers, at 8 p.m.

14th.—Institution of Electrical Engineers, at 8 p.m. Leeds Association of Engineers: Annual Meeting and Election of Officers. Mining Institute of Scotland: Annual Meeting at Hamilton.

15th.—Institution of Mechanical Engineers, at 8 p.m. City of London College Science Society, London College, at 8 p.m.

16th.—North-East Coast Institution of Engineers and Shipbuilders: Graduates meet at Middlesbrough. Midland Counties Institution of Engineers, the Midland Institute, Leeds.

19th.—Institution of Civil Engineers, at 8 p.m. Institution of Engineers and Shipbuilders in Scotland.

20th.—Birmingham Local Section Institution of Electrical Engineers, at the University.

21st.—Institution of Mining and Metallurgy, at 8 p.m. Birmingham University Engineering Society meet.

22nd.—North-East Coast Institution of Engineers and Shipbuilders meet. Institution of Civil Engineers: Students meet at 8 p.m.

25th.—Society of Arts: Cantor Lecture.

26th.—Institution of Civil Engineers, at 8 p.m.

28th.—Institution of Electrical Engineers meets. Liverpool Engineering Society: Annual Meeting at the Royal Institute. Leeds Association of Engineers, meet at 7.30 p.m.

30th.—Staffordshire Iron and Steel Institute: Annual Meeting.

GERMAN RÉSUMÉ.

BY

DR. ALFRED GRADENWITZ.

BERLIN, March 22nd, 1904.

The Use of Steam Power in Prussia.

The increase in the use of steam power in Prussia since April 1st, 1902, is shown by the following table, for which we are indebted to the "Zeitschrift des Vereins Deutscher Ingenieure." This table does not include locomotives, boilers or engines used for the Army and Navy. The Marine boilers and Marine engines recorded are exclusively used for propelling ships, while these also include 698 steam boilers, with 1,910 steam engines for the operation of steam dredgers, cranes, etc. The latter are, according to their design, classified together with stationary or transportable steam boilers and engines :—

	1902.	1903.	Absolute increase.	Increase Per cent.
Stationary steam boilers	72,098	73,181	1,083	1·50
Stationary steam engines	77,583	79,257	1,674	2·16
Transportable steam boilers	22,259	23,211	952	4·28
Steam engines connected thereto ...	21,612	22,556	944	4·37
Inland steamships ...	1,757	1,814	157	8·92
Steam boilers thereon	1,984	2,047	63	3·16
Steam engines thereon	1,946	2,018	72	3·70
Sea steamships ...	502	535	33	6·57
Steam boilers thereon	675	722	47	6·95
Steam engines thereon	533	571	38	7·15
Marine boilers, total	2,659	2,769	110	4·14
Marine engines, total	2,479	2,589	110	4·44

High Speed Locomotives.

M. Buhle, in a paper recently published in Dingler's "Polytechn. Journal" (Vol. 319, No. 8), describes a high-speed locomotive designed by Messrs. Henschel and Sohn, Cassel, for commercial speeds of about 130 kilometres. This locomotive is being tested on the Marienfelde-Zossen military railway in connection with the steam locomotive high-speed trials organised by the Prussian railway department as an indirect consequence of the famous electric traction trials. This engine has two trucks and two driving axles, a heating surface of about 260 square metres and about 4 square metres of grate surface, corresponding almost entirely with the conditions enunciated in 1902 in connection with the High Speed Railway Competition of the Verein Deutscher Maschineningenieure.

Another type of locomotive described by the author is the hot-steam locomotive designed by Dr. H. Mehlis, to whom one of the prizes in the above competition was awarded. The engine is a 2-6 coupled tender-engine with a front and a rear truck; this type was chosen on account of the fact that tenders of the usual design, even in the case of the water capacity being as high as 20 cubic metres, have too small a distance of the wheel centres for warranting a steady run with speeds ranging between 120 and 150 kilometres per hour. The distance of the wheel centres is 12·4 metres, and the boiler axle is, in accordance with American practice, placed at a distance of 2·55 metres above the upper edge of the rail. The locomotive has four cylinders with four cranks, acting on the rigid front axles. The weight of the engine, at no load, is about 58 tons, whereas the working weight is estimated at about 76 tons. Of the heating surface in contact with the water, measuring 146 square metres, about 126 square metres are intended for conveying the train, while 20 square metres are reserved for the electric lighting, generated by a 15 h.p. Laval steam turbine, the operation of ventilators, braking, heating, etc.; in addition 34 square metres of superheat heating surface are provided.

Precautions for Increasing the Safety on the Berlin Underground Railway.

Shortly after the Paris disaster a commission was appointed for causing such precautions to be taken as would be likely to increase the safety on the Berlin underground railway. These have now, for the greater part, been carried out. The lighting of the tunnel has received an additional independent wire, which, in the case of one half of the lamps being injured, will enable the remainder to go on burning. The conductor's stands on the underground railway stations are so designed as to be readily pushed aside. The number of fire hydrants has been increased, and each car has been fitted with a sand box. There are bucket fire engines in each car, as well as in the tunnel at distances apart of 100 metres. Each station has been connected to the fire brigade alarm line. The emergency lamps in the cars are prevented from any contact with the curtains, the latter being, moreover, of a heavy impregnated wool stuff. Each motor-man's stand is provided with short-circuiting devices which may be operated even from within the car, serving to cut the current out of the line.

Telegraphing Pictures and Handwriting.

In an address recently delivered at the Berlin Urania, Professor Cerebotani presented a telegraphic apparatus for transmitting any kind of handwriting, drawing, etc. The fundamental principle is identical with the principle employed for instance by Elisha Gray, the novel feature being a singular highly sensitive system of electromagnets. In older schemes, in which the drawing pencil of the transmitter was moved upwards in an oblique direction, the line obtained in the receiving apparatus was a broken one. In the Cerebotani system the electromagnets are so sensitive as to produce nearly straight lines even in the case of their being excited by extremely feeble currents.

The telegraphic transmission of pictures and handwriting, as obtained by means of his apparatus, is therefore much clearer and truer than with any previous apparatus. Some samples produced by Cerebotani were transmitted on the telegraph lines from Munich to Augsburg, from Milan to Turin, and finally from Berlin to Munich. A picture transmitted some days ago from Berlin to Munich over a distance of 650 kilometres is said to be the finest specimen ever telegraphed.

The Berlin-Hamburg High-Speed Railway.

Both of the two schemes for an electric high-speed railway between Berlin and Hamburg, which have lately been presented to the Prussian railway department, provide an electric central station to be installed in Wittenberge, being the main station between Berlin and Hamburg. It is anticipated that the journey between the two cities, which at present requires upwards of three hours with the fastest rapid trains, will eventually be made in one and a-half hours only. As a matter of course, a new road-bed will be necessary, but the cost of this reconstruction does not seem to be prohibitory. The fact that a third track has been found necessary (which in the case of the electric high-speed railway being installed could evidently be dispensed with) is illustrative of the dense traffic obtaining between the two largest German cities.

The Use of Wind-Motors for Generating Electricity.

At a recent meeting of the Leipzig Electrical Society, Mr. R. Brauns delivered an address upon modern steel wind-turbines and their use for generating electricity. Similar wind-motors, with devices for automatic adaptation to the direction and strength of the wind, have been built in America by Halladay; the principal drawback connected with it being the large number of levers and rotating points required. The "Ultra-Standard" motor on the other hand, while showing the same defect, allows of higher efficiency as the working surface is not too great as compared with the inlet opening for the wind.

The Herkules wind-turbine, built by the Deutsche Windturbinen Werke, Dresden, shares many features with American wind-motors, where the whole of the wheel is gradually withdrawn from the action of the wind as for increasing intensities of the latter a higher pressure is produced on one side of the wheel, which is sufficient to overcome the tension of the springs supporting the wheels at right angles to the main vane, the surface exposed to the action of the wind being diminished by its being placed in a position parallel to the direction of the wind. The Herkules motor, however, is capable of being built up to the highest sizes, the regulations with respect to the intensity of the wind being made so accurate by a lateral regulating vane as to warrant an absolute safety against storm and a uniform number of revolutions. This regulation of the wind-turbine is sufficient to ensure a uniform operation of the dynamo. There is an automatical switch inserting the dynamo in connection with its accumulator battery as soon as the number of revolutions has reached suitable figures, and disconnecting it as soon as the strength of the wind is no more sufficient; the whole of the operation being automatical, no supervision is necessary. As, on the other hand, the vanes of the turbine are paddle-shaped, showing helicoidal contortions, the output is said to be 30 per cent. upwards of that of existing wind-motors. The battery may even be charged with a wind only four miles per second in speed.

These motors have for some time past been used for driving even large-sized threshing machines and other agricultural as well as wood-working machines.

Producer Gas-Plant for Brown-Coal Briquette Operation.

An electricity works, comprising a 100-h.p. producer as dynamo, which was recently installed in Hoyerswerda, Germany, appears to be the first central station where the producer gas-plant is operated by means of brown-coal briquettes. The gas-motor is quite identical with those used in connection with lighting and anthracite generator-gas, the producer gas-plant being also quite analogous to the usual design, being made up of the generator proper, the dust collectors, the scrubber, and the sawdust cleaner. After this means of operation had been adopted in October last, it has been carried on continuously with most successful results and without any disturbances, working about fourteen hours daily; no reserve was so far provided. Now another similar gas motor of the same output is at present being installed. Tests made some time ago showed the piston to be free from impurities from tar or paraffin. The brown-coal briquettes used were composed as follows:—

Carbon	48·32 per cent.
Hydrogen	3·35 ,,
Oxygen and nitrogen ..	26·54 ,,
Sulphur	1·09 ,,
Ashes	5·00 ,,
Moisture	15·70 ,,
Total	100·00 ,,

The heating value is 4,853 heat units.

A rough experiment, intended for ascertaining the consumption of fuel which was made during ten hours (the briquettes being unloaded from weighed buckets and the output being read on the ampere and voltmeter) gave the value of 0·65 kilogrammes per h.p. hour.

Operating generators with brown-coal briquettes proves in many respects more convenient than anthracite operation, the generator being never obstructed by slags. After the normal pauses in operation, it may be started again without any blowing-in; the door leading to the ashpit may be opened during the operation so as to clean the grate, which on account of the absence of any slag is rather easy and simple.

As Germany is mainly compelled to derive her supply of anthracite from abroad, the use of brown coal is likely there to afford a convenient fuel at a lower cost; the use of brown-coal briquettes seems to be especially suitable to small concerns in the centre of cities, on account of the possibility of having a supply of brown coal even in small quantities, as well as of the cleanliness and commodity of its storing up. This will no doubt serve to further the development of producer gas-plants.

MINING NOTES.

By A. L.

The Coal Tax.

At a National Conference of coal miners of Great Britain representing seven hundred thousand workmen, held at the Westminster Palace Hotel, the chairman (Mr. Enoch Edwards) said they ought again to ask the Chancellor of the Exchequer to remove the iniquitous tax upon all exported coal. It was said that the tax would fall upon the foreigner, and that it would not affect the coalowner or the miner. But he wanted to know how the Chancellor of the Exchequer would explain how it was that before the coal tax was imposed France only took 3,000 tons of coal from Germany, but last year she received no fewer than [illegible] tons, the whole of which used to come from this country. The situation had changed since this coal tax was imposed, when there was a boom in trade, but now that it was depressed the tax was being severely felt. A letter was read from Mr. Austen Chamberlain, who said that until the Royal Commission on Coal Supplies of this country had completed its inquiries and issued its report, he felt precluded from making any addition to the statements made by his predecessors on the subject, and therefore he felt that no useful purpose would be served by his receiving a deputation such as they proposed at the present time. After a lengthy discussion it was resolved unanimously: "That we continue to protest against the tax on exported coal until the tax is repealed, and that we protest against the action of the Chancellor of the Exchequer in refusing to meet a deputation representing the miners of the United Kingdom." It was urged, and very generally accepted, that there should be a federation of the whole of the coal trade organisations, and if necessary to secure a living wage, the whole of the miners should cease working. The question of the Trades' Disputes Bill was also discussed, and it was resolved to support the Bill.

Spontaneous Combustion in Mines.

The question of fires in mines, with more particular reference to coals in the North Staffordshire coalfield, was discussed at a meeting of the North Staffordshire Institute of Mining and Mechanical Engineers. Mr. G. E. Lawton, the author of the paper, remarked that the principal causes of fires in mines were spontaneous combustion of the coal or of the material in the goaf, accidental ignitions of timber by open lights, explosions of fire-damp, underground boilers, furnaces, steam pipes, electrical appliances and shot firing. The most common cause of pit fires was spontaneous combustion. Perhaps there was no coalfield which contained more seams of coal subject to take fire spontaneously than the North Staffordshire coalfield. Fires had occurred in the Great Row, Cannel Row and Rowhurst coals in the Hanley district, and in the Yard Seam in the Longton and Fenton districts. Incipient fires in the Ten Feet Seam had been experienced in the Burslem district. The Seven Feet Banbury took fire in the north-western part of the coalfield, and the Eight Feet Banbury, or Cockshead coal, had taken fire in the Longton and Talke districts. The Bullhurst Seam, which was notorious for the frequency of fires, appeared to be liable to take fire, more or less, over the greater portion of the coalfield. Small coal constituted one of the most important factors in the origin of spontaneous combustion, but many other agencies assisted in bringing it about. One theory was that combustion was brought about by physico-chemical actions and reactions of gases, liquids and solids, other agencies which appeared to propagate combustion were oxidation of coal or surrounding material; also rock pressure.

Gob-fires of the worst type had been produced where slack had been left behind in the goaf, and these fires were greatly facilitated by allowing slight currents of air to pass through the goaf.

That Bete Noir.

At the annual meeting of the Association of Mine Managers of the Transvaal, the chairman, Mr. R. M. Catlin, remarked he would not burden the patience of the meeting by an extended reference to that "bete noir" of all their meetings, "the native labour question," but years of habit would preclude the omission of the phrase in any assembly in that place whose walls must be surcharged with the sound. Mechanical ingenuity had done, and was doing, much to cheapen the cost of production, but there was a limit beyond which these improvements could not go—there must always be use for the "hewers of wood and drawers of water." The presence there of a quantity of cheap labour had probably had quite as much to do with the building up of the industry as the presence of the gold in the reef. In fact, it was probably the more important factor of the two, for the gold contents was an immutable fixed fact which no social or political upheavals or other act of man could alter, while the cost of production was helplessly dependent on the other factor, which could be made the shuttlecock of party politics. But the fact remains that if those fields were to be fully worked there must be a sufficient supply of unskilled labour, and as it was clearly the one condition on which all other South African problems depended, it seemed fair to assume that sooner or later the solution of that problem would be found.

Among the advantages enjoyed by the industry, not the least was the happy arrangement of the mining laws, which seemed to minimise litigation. Few new mining regions had so signally escaped the blight of litigation. The report of the council dealt very fully with the various matters that have come before the Association during the year. A new set of mining regulations had been provided by the Government, and it was evidently the earnest desire to make them as perfect as possible, and to consider such improvements in them as practical experience might suggest. They were framed with great care by the Government, after consultation with the various interests involved, and, while time and experience might suggest some alterations, as a whole they reflect great credit on the care and patience of the official who prepared them.

In the course of further remarks the chairman said the coming year gave promise of better times. Much of the legislation necessary for the proper conducting of the industry had already become law; the country was fast settling down to the new conditions, and it was to be hoped that before the year closed the industry would be in a fair way to even greater prosperity than it had ever enjoyed.

A New Electric Mining Plant.

For the Gwendreath Valleys Anthracite Company the British Westinghouse Company are supplying and erecting a generating plant with all accessories and numerous motors. The plant will be on the three-phase system and will have a capacity of [illegible] kilowatts; the motors will be all of the Westinghouse polyphase induction type. They will be utilised to drive pumps, a 100 h.p. main and tail haulage and Waddle fan with a capacity of 50,000 cubic feet per minute, etc.

OPENINGS FOR TRADE ABROAD.

Belgium.

Tenders for the construction of shipbuilding yards, stocks, etc., will be opened on July 28th next, in the Bureaux du Service Spécial de la Côte, at Ostend.

On April 6th tenders will be opened for the construction of a railway between Kieldrecht and Doel, at the estimated cost of about £4,000.

Peru.

The Board of Trade have received from H.M. Minister at Lima, copy and translation of a Law regulating the tenders to be offered to the Peruvian Government, within one hundred and twenty days from January 14th, for the construction and working of the projected railway between Lima and Pisco.

The maximum capital necessary to carry out the work is estimated at £500,000, on which the Peruvian Government guarantees interest at the rate of seven per cent. per annum to the contractor, during twenty-five years from the day that the principal line is handed over to public traffic.

To guarantee the execution of the contract, the sum of ten thousand pounds, Peruvian, or its equivalent in bonds, must be deposited before signing the deed, and no tender will be accepted unless it is accompanied by a receipt showing that ten per cent. of this amount has been deposited.

Portugal.

Tenders will be opened on May 24th in the Directorate of the Caminhos de Ferro Ultramarinos, for the exclusive concession during fifteen years, for running automobiles for the transport of persons and merchandise from Mossamedes to Chibia. The tenderers must be Portuguese citizens or companies.

Ottoman Empire.

There will shortly be an opening for agricultural machinery in Turkey. The Turkish Government have decided to allocate an annual grant of £T3,000 (£2,700 sterling) for the encouragement of agriculture in the districts of Samsoun, Angora, Sivas and Konia. Half this sum will be devoted to the purchase of agricultural machinery.

Mexico.

A contract has been made between the State and Don Wenceslao Garcia for the construction and working for ninety-nine years of a railway of 9·14 mm. gauge, in the State of Oaxaca, from the capital of that State to Tlacolula with a branch to Tlalixtac. The period for free importation of materials and supplies, to which Article 74 of the Railway Law refers, is to be five years.

Argentina.

Tenders will be opened on April 15th next, in the Ministry of Public Works, Buenos Ayres, for the construction of the prolongation of the railway and buildings corresponding thereto, supply of rolling stock etc., from Chambicha and Rioja to Andalgalá, with a branch from Mazan to Tinogasta, on the terms which those interested may consult in the Directorate-General of Ways of Communication, Buenos Ayres.

The right to build and work a railway line, either 1 metre gauge or 1·66 metre gauge, from the port of Rosario on the River Paraná, to the port of Belgrano on Bahia Blanca, has been granted to Don Diego de Alvear, according to the plan which the Government may approve. Materials for the construction of this railway not produced in the country may be imported free of duty for twenty years from the date of the contract, during which period, moreover, the line is to be free of national taxes.

The French Railway Company, of the province of Santa Fé, have the right to construct and work a metre gauge railway line from the "La Sâbana" station to the port of Barranqueras, on the River Paraná passing through the town of Resistencia, as well as a wharf, warehouses, etc., in the port of Barranqueras. Materials for the construction and working of this railway which national industry does not produce may be imported free of duty.

Cuba.

The Directorate-General of Communications, Havana, invites tenders by April 15th for the establishment and working of a telephone system in the town of Guantánamo. A provisional deposit of 200 dols. is required to qualify any tender.

Spain.

The towns of La Solana and Membrilla, province of La Mancha, require tenders for the supply of electric light for twenty years. In the case of La Solana the municipality require to be supplied with 2,000 c.p. and will pay 6,000 pesetas (about £173) per annum as a maximum, whilst in the case of Membrilla the municipality require 1,250 c.p. and will pay at the rate of 4,000 pesetas (about £116) per annum as a maximum.

There is a demand for tenders, which will be opened on April 9th in Malaga, for the concession to construct and work an urban tramway by animal power from the station of the Malaga and Cordoba railway to the working-class suburb of Huelin. In the same municipality, on April 4th, tenders will be opened for a concession to establish and work a tramway by animal power from the Plaza de Riego to Calle de Torrijos. A Royal Order has been issued requiring that the calls for tenders for the establishment of telephone systems in El Escorial and Palamós, which were suspended by the Royal Order of September 9th last, shall now be renewed at the earliest date possible.

OUR TECHNICAL COLLEGES.

BY

A TECHNICAL STUDENT.

THE SUGGESTIVENESS OF STUDENTS' PAPERS.

Professor A. C. Elliott, D.Sc., of the University College of South Wales, Monmouthshire, Cardiff, sends me an excellent suggestion to the effect that these columns might with advantage contain occasional reports of the College Engineering Societies. "Our society," says Prof. Elliott, "has been going for more than ten years. It recently paid a visit to the Severn tunnel pumping station and arrived on the ground to see the biggest output for 27 years—viz., 34,000,000 gallons in 24 hours." He further remarks that long ago the Institution of Civil Engineers recognised the claim of the student class to a representation in the proceedings, and the foresight has been amply justified. Says Prof. Elliott: Students' papers are, as all who have had any experience will vouch, extremely suggestive and the errors simply set older men thinking of the days when they were young, not usually a wholly unpleasant experience. I welcome the suggestion and shall be glad to act upon it. Secretaries of College Engineering Societies are hereby invited to co-operate.

"THERMOTECHNICS" AT THE CITY AND GUILDS' TECHNICAL COLLEGE, FINSBURY.

During the past three years the course of instruction in "Heat" for evening students, at the City and Guilds' Technical College, Finsbury, has been modified so as to bring the subject more into touch with workshop practice. As by far the greater portion of the students attending the lectures and laboratory are connected with engineering trades, the value of a thoroughly practical course in this subject is manifest. The lectures have been devoted, firstly, to the general principles of the science, and afterwards to such matters of commercial import as refrigerating machinery and cold storage; properties and evaluation of the different classes of fuel; steam boiler economy and the properties of steam; modern pyrometry and its applications; and the consideration of steam and other engines from the standpoint of thermodynamics. The lectures throughout have been illustrated by experiments, and diagrams or lantern slides of the actual appliances used in workshops or factories. In the laboratory, the preliminary work has been devoted to the determination of the various thermal constants, such as co-efficients of expansion, specific and latent heats, etc., so as to familiarise the student with practical methods of determining heat quantities accurately. The more advanced work has consisted in the determination of the calorific value and other properties of fuels; the comparison of different heat insulators; the standardising and use of a thermal-couple pyrometer; finding the connection between the temperature and pressure of saturated steam; and the determination of the vapour pressure of volatile liquids, such as petrols, ether, etc., with a view to finding the conditions for the safe storage of these liquids.

The course, as outlined above, has proved to be extremely successful with the class of students attending the College, and a greatly increased attendance has resulted. With the advantage of a more commodious heat laboratory in the proposed extension of the buildings, greater facilities will be afforded for carrying out this scheme of instruction, which could, no doubt, be copied with advantage by other institutions conducting evening classes for engineering students. The lectures and laboratory work have been conducted by Mr. C. R. Darling, A.R.C.Sc.I., Wh. Ex., under the direction of the Principal of the College, Dr. Silvanus P. Thompson, F.R.S.

MINING LECTURES IN THE SHEFFIELD DISTRICT.

In a recent report on the work of the Mining Department of the University College of Sheffield, Professor Hardwicke points out that although previous to the Session 1891-1892 several courses of lectures on "Mining" had been delivered at the college by Mr. Blake Walker and Mr. Cobbold, no organised department had been attempted. "The work of the present department," he says, "commenced in October, 1891, and consisted then of a first year's Saturday Afternoon Course in mining, for which thirty exhibitioners from the West Riding and Derbyshire County Councils were entered, of a large number of peripatetic lectures in the West Riding and in Derbyshire, and of a share in the Barnsley mining classes.

After reviewing the history of these lectures during the preceding years, he remarks:—

"In the Session 1896-1897 our present 'Advanced' course for day students was commenced; arrangements were made by which articled pupils and others who could spare the time could attend the College two days per week for three years.

"In the Session 1897-1898 the class for mining teachers was commenced. The permanence of the local classes in Derbyshire had been established, and the West Riding County Council were preparing to arrange for similar classes, but it was felt that the teachers of these classes (who as a rule were and are men actively engaged in colliery work) needed some training in the art of teaching; this class was therefore instituted to meet this need. The number of West Riding peripatetic lecture centres was reduced to seven, and in the following Session to four. In this Session the connection between the Barnsley Mining Class and the Colleges was severed, and Barnsley became a local centre instead of a collegiate course.

"In Session 1898-1899 the local centres in 'Mining' were commenced in the West Riding, and the college was entrusted with the inspection, organisation, and examination of the classes.

"In the Session 1899-1900 the Saturday afternoon class in 'Electricity applied to Mining' was established. The Derbyshire County Council arranged to grant ten exhibitioners for this course, and this enabled us to make a start; in the present Session the West Riding County Council has also given its support to this class.

"In conclusion, I must point out to you how greatly we have been aided in our work by the hearty co-operation and goodwill of the County Councils of the West Riding and Derbyshire. Apart from the fact that the department is entirely supported by their contributions, we have always worked on the best of terms with them and their representatives; any suggestions we have made have been readily met, and we have been assisted by them to branch out into new lines of work to meet fresh needs which have from time to time arisen."

NOTABLE BRITISH PAPERS.

A Monthly Review of the leading Papers read before the various Engineering and Technical Institutions of Great Britain.

TRANSATLANTIC ENGINEERING SCHOOLS.

THE paper on Transatlantic Engineering Schools and Engineering, by Dr. R. Mullineaux Walmsley which forms the basis of criticisms by Mr. E. C. de Segundo in the present number, was contributed to the Institu tion of Electrical Engineers, and is a lengthy document, including a valuable collection of facts and figures regarding technical education in the United States. This information was obtained last year in the course of a tour by Dr. Walmsley undertaken at the instigation of the Governors of the Northampton Institute. Altogether about thirty-four universities, colleges and schools, and forty-eight factories were visited, numerous interviews being held with business men.

Many of the universities visited possess fine buildings situated in extensive grounds, and the engineering department is usually prominent. The workshops, as a rule, are lavishly equipped, and the laboratories even more so. Manufacturers are very generous in their gifts to the colleges, one firm building a special full-sized locomotive, which was presented to a college for testing purposes. The electrical laboratories cannot be extended fast enough to accommodate the increase in the number of students, but they are equipped throughout with modern and efficient apparatus and machinery.

For electric traction work the University of Illinois at Urbana has, in conjunction with the Illinois Central Railway Company, built and equipped an experimental car which can be attached to any train so as to furnish data obtained under actual working conditions. The car was provided by the railway company, and equipped with its instruments and fittings by the university. The Brooklyn Polytechnic is allowed from time to time by the local street railway company to use part of its track for experimental work, the company supplying the necessary current and an operating staff.

TEACHING STAFF.

It is recognised in the United States and Canada that in addition to sound academical training the teachers should possess considerable experience as engineers. It is not the men who have been in practical life and have failed that are wanted, but men who have had practical engineering experience and have been successful in it. Even with the large resources at the disposal of the colleges, however, their present financial position is not strong enough to enable them to offer the salaries for heads of departments which the necessities of the case require. It is the universal custom to *require* teachers to engage in outside consulting work.

FINANCES.

From a financial point of view the transatlantic engineering colleges appear to be on a better footing than those in England. Although a considerable amount of money is given in large sums by millionaires, the extent of the smaller contributions from a great number of individuals does not seem to be realised. In the year ended August 31st, 1902, a sum not far short of £100,000 was received by the University of Pennsylvania from private donors. These donors numbered about four hundred separate individuals and although there are one or two large amounts, including one of £10,000 and another of £5,000, the bulk of the money came from the large number of much smaller contributions. There was also a single donation of £100,000.

STUDENTS AVAILABLE AND CONDITIONS OF ENTRANCE.

The basis of the American and Canadian educational system is the common or public school which the child enters at the age of six. At ten he is transferred to the grammar school, which forms the intermediate stage between the primary and the secondary school. Here he remains for four years, and learns very little beyond elementary English and arithmetic. Such students as can then afford to pursue their education to a higher level enter either the high school, with its classical and modern side, or the manual training high school or manual training school, in which workshop instruction forms a large part of the curriculum. At this stage the usual courses extend over another four years, but in some of the manual training schools they cover only three years; generally, therefore, by the time the student has gone through the whole course he is eighteen years of age. These schools take charge of the stage of education which is immediately preparatory to the entrance to the universities and technical colleges, but the majority of the pupils do not carry their education further, but pass direct from them into ordinary life.

Taking first the manual training high schools and the manual training schools, a large proportion of the time, often approximating to one-third of the whole, is spent in the workshops, the remaining time being given to mathematics, drawing, science, literature and modern languages. In the high schools, on the other hand, there is a classical course, and often, in addition, what we should call in this country a modern side, in which modern languages and science take the place of Latin and Greek. Mathematics is, of course, taught in all sections of the school. Under certain conditions, the student is permitted to choose for himself the subjects which he intends to study, and the author does not consider this advisable.

Students for the classical sides of the high schools frequently make better engineers than those who have gone through the manual training schools.

Owing to later age of entrance and to their general education having, as a rule, been carried to a higher point, the candidates for technical courses in America are more able to take advantage of the training than their English cousins. The American navy, army and civil service do not prove such formidable competitors as the corresponding British services in the demand for men who would otherwise take up engineering. Many students in America are men who have had to support themselves from a comparatively early age, and who, after saving up sufficient money, often go through a four years' course when well on in life. Entrance of students under eighteen years of age to technical institutions is strongly discouraged. In nearly all cases an entrance examination is set, which is more difficult than the matriculation examination of the University of London. English is a compulsory subject in every instance, but there is a certain amount of variation regarding other subjects in the different schools. There is a tendency, in institutions of good reputation, to still further raise the conditions of entrance, this being due to the fact that the increasing number of candidates is severely taxing their resources and accommodation.

FEES.

Fees for tuition range from nothing up to £52 per annum, according to the locality and status of the school. The highest fees are charged at the eastern universities, but tuition is practically free to residents in the middle-west States, as these latter derive a considerable part of their income from the State. There are a great number of free scholarships in connection with several universities. The cost of living is comparatively low at Canadian institutions.

It seems to be a common opinion that four years is insufficient for the work to be done, and there is a movement on foot either to give a longer preliminary training or to lengthen the time spent in the professional school. Although the age of entrance is late, the preparation is not so good as it might be, and an attempt is made to remedy this state of affairs by devoting a large amount of time to teaching non-professional subjects during the first two years, thus crowding much highly technical work into the remaining two years.

POST-GRADUATE COURSES.

A complete statement is given of the total number of hours devoted to different subjects in several institutions. In most of the colleges post-graduate courses of a very elaborate nature are organised, the student is allowed to select his particular line of work, and the full resources of the laboratory, together with the help of the professorial and artisan staff, are placed at his disposal. Much very valuable work has emanated from these courses. In the sixteen institutions which Dr. Walmsley discusses there were as many as 1,134 students doing fourth-year work, and 237 post-graduates students.

EMPLOYMENT FOR GRADUATES.

Inquiries among principals and employers revealed the fact that there is never the slightest difficulty in finding remunerative employment for graduates, indeed many of the latter secure appointments before their course is completed. The premium system is practically non-existent and the large firms start graduates at a living wage, at the same time giving them every opportunity to improve their position. Another direction in which the employers help the colleges is in practically throwing open their workshops during the summer vacation for the undergraduates to obtain workshop practice under commercial conditions. No undergraduate who is willing to work need be at a loss in America to find a shop in which he will be welcomed and given every reasonable facility. The firms giving such facilities say that they are amply repaid by becoming acquainted in advance with the real value of the men who are graduating, and in the data they require for making their selection when the time comes.

TECHNICAL EDUCATION IN ENGLAND.

Modern trade developments are moving so rapidly that, for the moment and until the reform of secondary education, now so strongly advocated, have been accomplished, the author considers it would be disastrous to stand still. We must press forward our technological education and make the best of the materials which are available. At any rate, a proportion of the secondary education which is being given is good, and we shall obtain at least some students who are well fitted to take advantage of more than all that we can put before them. He advocates the abolition of the premium system, the better equipping and staffing of the technical schools, more encouragement at home for graduates—the adoption of some form of the sandwich system—and wider knowledge than college training is absolutely essential. The employers and manufacturers hold the key of the position.

THE WAGON PROBLEM.

At a meeting of the Institute of Civil Engineers, Sir William H. White, K.C.B., president, in the chair, papers were read on "The Construction of Railway Wagons in Steel," by J. D. Twinberrow, Assoc.M.Inst. C.E.; "The Construction of Iron and Steel Railway-Wagons," by A. L. Shackleford, Assoc. M.Inst.C.E.; and "Iron and Steel Railway-Wagons of High Capacity," by J. T. Jepson. The following are abstracts:—

MR. TWINBERROW'S PAPER.

The first paper begins with a comparison of the physical qualities of timber and steel. The limit of elasticity of white oak is nearly equal to the ultimate strength, and the modulus of elasticity is low, so that a timber frame, by reason of the extent of its elastic deflection, has great capability of absorbing shock. The lateral stiffness of planking is greater than that of unstiffened steel plates of equal weight. The joints of wooden frames are a source of weakness. Rectangular sections are alone practicable for timber beams; the safe load on a rolled joist is compared with that upon an oak beam of similar depth, and the section and weight of beams of equal strength are compared.

In British practice solebars, headstocks, longitudinals, and transoms are usually of similar section; in Continental practice the inner members are shallower than the soles, crossing above or below each other, thus simplifying the joints at points of intersection. The ratio of the load-gauge to rail-gauge is considered; the inadaquacy of the former is stated to be due to the restrictive influence of the design of rolling stock with rigid wheel-base.

The use of bogie trucks is considered to be desirable when the weight on the axles is increased; the adoption of bogie lead or apparatus to control the lateral

and angular deflection of bogies is recommended. Bearing-springs in series are to be preferred to single springs of greater flexibility. The practice of arranging the side frames of the bogie and the axle-box springs and axle-guards in the vertical plane through the centres of the journals is preferred to the usual European practice of setting back the frames and axle-guards to provide room for laminated springs over the axle-boxes.

Designs were illustrated as an embodiment of the idea that a steel wagon should be a complete structure, in which all parts necessary for containing the load contribute to the strength and stability of the whole, whilst the component parts are plain rolling-mill shapes of standard section, assembled without the aid of special forged or pressed work.

The sides of the wagons are formed of plate girders, of which the depth is so considerable, in relation to the span, that deflections under working load are quite inappreciable.

Special stress is laid upon self-discharging vehicles, on account of the great economy effected by their use in the manipulation of minerals and other bulk freight at terminals. The ends of these wagons and the lower parts of the sides converge to openings at a suitable height above the rail-level. A special form of door which travels on horizontal guides is described; the prominent features of these doors are the facility they afford for providing a long base line for intersection of the end slopes, their security against accidental opening, and the ease with which they may be closed to retain any desired portion of the load.

Hand-brakes are operated by means of a screw with pull-rods connected so as to transmit the pressure to each wheel of each bogie, and to permit of the coupling up of air or vacuum-cylinders as required.

The defective action of ordinary side buffers with screw couplings on sharp curves is mentioned, and the conditions for eliminating it are noted; central couplers are referred to; and the capacity of friction draft-gear is compared with that of the standard buffing and draw-gear of private owners' wagons.

The practice of weighing long wagons on short weigh-bridges is also alluded to.

THE CONSTRUCTION OF IRON AND STEEL RAILWAY WAGONS.

The second paper, by Mr. Shackleford, deals in the first place with the advances made in the construction of railway wagons during the last thirty or forty years, detailing the successive steps from the wagon built entirely of timber, which was in vogue at the commencement of that period, down to the latest form of wagon made entirely of iron or steel, and the advantages accruing from this form of structure. The author compares the strength of timber and metal, and shows that for a 10-ton wagon built to the English standard regulations, a steel frame can be made much lighter than a timber frame to carry the same load; while the strength of the timber frame is not to be compared with that of the steel frame.

He describes the changes that have taken place in the form of construction of steel underframes and bodies. A great advantage of steel frames is the ease with which the various members can be replaced, owing to all drilling and machining being done either with steel-bushed templates, or by means of multiple drills and other modern metal-working machines, so that complete interchangeability is ensured.

Another point of great importance is the protection of iron and steel plates, channels, angles, etc., from rust and subsequent corrosion; and he points out that wherever practicable this should be accomplished by a coat of boiled oil, or of some suitable paint, as soon as possible after the metal has left the rolls. The omission of this precaution is frequently attended with disastrous results, as when once corrosion has been set up the metal is very soon destroyed, and in a short time it is useless for all practical purposes. The author lays particular stress on this point, as the very existence of the wagon depends upon it. On the other hand, when a metal wagon has been well taken care of and properly painted from time to time, it has been proved that the loss through corrosion is insignificant, and the wagon may be expected to last several times as long as one built of timber, for no amount of attention and painting will preserve timber for anything like the same length of time.

The author points out that although the cost of a metal wagon is at present somewhat higher than that of a timber wagon, the action of the Engineering Standards Committee in arranging certain approved sections will tend to reduce it greatly; and it may be expected that before long a wagon built of iron or steel will be produced at the same or even at a lower cost than one built of timber. With regard to the question of whether a large bogie-wagon or a four-wheeled wagon would be more economical for carrying goods on English railways, the author gives his opinion in favour of the smaller wagon, pointing out that loads in England are frequently too small, and the distance to be run too short, to allow of the use of a larger wagon; in fact the average load which it is convenient to put in an English wagon averages under 5 tons.

A table giving a comparison of the ratio of load and tare for some of the principal wagons built under the author's supervision shows that the tare of a wagon built entirely of steel is much lower per ton of load than that of a wagon built entirely of timber.

THE HIGH-CAPACITY PROBLEM.

In the third paper, by Mr. Jepson, the wagon problem as affecting English railways is first considered, and a list is given of the companies which are using and experimenting with wagons of higher carrying capacity.

The advantages of high-capacity wagons for coal-traffic are shown by the saving their use will effect in the tare or non-paying load, and in the lengths of trains; and the difficulties in the way of their introduction, both at the collieries and at the points of discharge, are dealt with.

The wagons described in the paper are designed for the conveyance of coal, and are suitable chiefly for traffic on the British railway systems. Several of the examples are of wagons already built and in traffic, which are proved in every way satisfactory, and have a lower tare than any other of the same class. They are all constructed of iron and steel, and are fitted with an either-side hand-screw brake, the self-discharging wagons having either-side door-operating and locking gear.

The questions of the limit to the carrying capacity of bogie coal-wagons for traffic in this country, and the most convenient size, are fully discussed, taking into consideration the limited load-gauge, the sharp curves, and the fact that the wagons have to be provided with corner buffers. The difficulty of using screw-couplings for these wagons is dealt with, and some examples are cited of large coal-wagons of the bogie type in use in the colonies. A tabulated list is also given of the bogie coal-wagons at present employed for traffic in Great Britain.

Proceeding to details of construction, the first example given and that with the lowest tare compared with the measurement load, is a 40-ton coal-wagon of the

flat-bottomed type, arranged for discharging by hand-labour through opening in the sides. Although fitted with laminated bearing springs, this wagon is shown to be the lowest in tare of various constructions, and at the same time exceedingly strong.

An important section of the paper is devoted to the construction and details of self-discharging wagons for the conveyance of minerals. The first example is a 40-ton wagon arranged so that the contents are discharged down a shoot between the rails, the mouth of the shoot being limited in length. A comparison is made between the work of receiving and discharging one of these wagons and wagons of the ordinary 10-ton type to carry the same amount of coal. Details of a test of two and a-half times the maximum working load, which was carried out on one of these wagons, are given and also the time taken to discharge 40 tons of coal.

Other examples are given of a 40-ton wagon of similar construction to the foregoing, but arranged to discharge its contents between the rails at three given points; an 80,000 lb. wagon for a 3 ft. 6 in. gauge railway, fitted with central buffers and arranged to discharge its contents outside the rails; a 100,000 lb. wagon, arranged to discharge part of its contents near the centre, and part near the ends of the wagon; and a 20-ton four-wheeled wagon arranged to discharge its contents between the rails at the centre of the wagon, and having a 10 ft. wheel-base, and less tare than any 20-ton flat-bottomed wagon in use.

Designs for 60-ton and 70-ton wagons arranged to discharge their contents between the rails are also outlined, showing the load it would be possible to carry with an increased load-gauge, such as that adopted in the United States and other countries.

TECHNICAL EDUCATION AT HOME AND ABROAD.

A USEFUL paper on Technical Education in which special reference is made to the Admiralty system, was read by Mr. B. C. Laws at a meeting of the North-East Coast Institution of Engineers and Shipbuilders. In his introduction, the author remarks that :—

One cannot but think that the engineer has generally speaking received meagre recognition in the world of science until comparatively recently.

The essentially practical man, who hitherto has more or less built up his fortunes unaided by scientific knowledge, has frequently derided the idea of education, and innumerable instances could be cited where it has been a positive disqualification for an applicant for a post to reveal that he held an educational diploma. In consequence progress has been retarded, and the rightful recognition of a place for engineering amongst the learned professions has been delayed.

The author proceeds to comment upon the beneficial work done by the Institution of Civil Engineers in fixing the necessary preliminary education and the scientific training of engineers. He also summarises the progress made in our universities, colleges, and technical schools.

RELATIVE VALUE OF SCIENTIFIC TRAINING.

In claiming for engineers the highest possible recognition in the world of science, the author does not detract in any way from the value of practical experience.

The highest scientific training obtainable can never produce an engineer, unless the particular individual knows by intimate contact with the practical side of his profession how to apply or even modify, if needs be, his theory to meet all the demands.

Theoretical knowledge is in no sense a substitute for practical experience, but the two judiciously combined can alone make the man able and ready to cope with the intricate problems which from time to time present themselves.

THE ADMIRALTY SYSTEM OF EDUCATION.

Giving a history of the Dockyard schools, he remarks that one of the greatest monuments to the efficiency of these schools is our modern Navy.

Such concurrent practical and theoretical training it is impossible to overestimate, and it appears to be the best solution to the question of the technical training of engineers.

While great credit is due to all who have so well maintained the honour of these schools, it must not be forgotten that in a great measure the success attending the training as in all instances of systematic instruction, must be largely attributed to those who have the responsibility of imparting the instruction.

The masters are selected by open competition, and with perhaps a few exceptions it has resulted in an Admiralty-trained candidate being successful often against highly trained men from our best universities and colleges.

From the beginning the schools have been run on the most economic lines both in point of the salaries paid to the teachers and of equipment of essentials necessary for the students. This may be readily seen by comparing the cost of upkeep not only with that of any other teaching department of the Navy, but with that of our technical institutions covering the same range of teaching.

With the recent appointment of Professor Ewing, F.R.S., as Director of Naval Education, it is hoped that the training of the young men in all departments of the service will be still further advanced. At the present moment he is engaged in the work of reorganisation where necessity requires it, and the energy already displayed by him is sufficient evidence of the important place which he considers these schools should occupy.

POSITION OF NAVAL ARCHITECTURE.

Discussing technical education in general, the author remarks that most of the branches of engineering are well represented in the majority of our technical institutions; naval architecture, however, upon which the growth of this Empire may be said more or less to have depended, has not been justly considered. Excepting the Royal Naval College, where a professional instructor is appointed from the Admiralty and the chair of Naval Architecture at Glasgow University, no other separate chair in this subject appears to exist, and this in a country eminent for shipbuilding and marine engineering.

When we sympathise with education—and especially technical education—as America and Europe do, we shall be able to hold our own against our competitors. No effort should be spared to obtain every advantage that a high technical training could give, and the best opportunities should be afforded those who had the best abilities.

(*To be continued.*)

BOOKS OF THE MONTH.

"THE METALLURGY OF STEEL."

By F. W. Harbord, Assoc.R.S.M., F.I.C., with a section on "The Mechanical Treatment of Steel," by J. W. Hall, A.M.Inst.C.E. Charles Griffin and Co., Ltd. 25s. net.

The literature of iron and steel has received a notable addition in "The Metallurgy of Steel," by Professor F. W. Harbord, Assoc.R.S.M., F.I.C., which forms one of Griffin's Standard Metallurgical Series. The author has gripped his subject in a masterly manner, and the outcome is a wonderfully comprehensive volume, replete with interest and invaluable both as a text book and work of reference.

A brief analysis of the work shows that it is divided into four parts. (1) The Manufacture of Steel; (2) Reheating; (3) The Mechanical Treatment of Steel; (4) Finished Steel. For the major portion, Professor Harbord is responsible, but Section III. has been handed over to Mr. J. W. Hall, A.M.Inst. C.E., whose special experience has enabled him to deal with the subject in a thoroughly practical manner. A feature which impresses itself upon the reader at an early stage is the excellence and frequency of the illustrations, comprising 37 folding plates, with 178 figures, some 280 illustrations in the text and nearly 100 micro-photographs of steel sections.

In the first section, dealing with the plant, machinery, methods, and chemistry of the Bessemer and the open hearth processes (acid and basic), special attention is given to recent steel plants in the United States and on the Continent, the latest types of steel furnaces, gas producers, etc., being carefully described and drawn to scale.

Discussing the Talbot continuous process, the author remarks that practically all processes that have been introduced to increase the output and improve the yield of the basic open hearth process have depended upon the use of fluid metal, with large additions of oxides, and the difficulty has always been to prevent the destruction of the hearth by the combined chemical action of the oxides and the mechanical abrasion of the fluid metal when poured into the furnace.

This problem of the treatment of fluid pig-iron of more or less irregular composition, as regards silicon or phosphorus, has been most effectively attacked by Mr. Benjamin Talbot, of Pencoyd, in what is known as the continuous open hearth process, which promises to be a great success. In this process a basic-lined tilting furnace is used, especially designed so that any quantity of slag and metal can be poured off at any time during the working of the charge, and also that large or small additions of oxidising agents, limestone, or metal can be added. The process of working is as follows:—Liquid metal, either from a blast furnace mixer or a cupola, is conveyed in ladles and poured, by means of a spout, into a tilting furnace of the Wellman or Campbell type; large additions of oxide and limestone are added, by means of a Wellman charger, and the whole charge worked down as rapidly as possible by further additions of oxides and limestone, from time to time. When finished, the greater bulk of the slag is poured off through a slag notch on the charging side, and then a *portion only* of the metallic charge, varying from 10 to 33 per cent. of the total weight of metal in the furnace, is poured off into a ladle, Ferro-Manganese added in the usual way, and the steel teemed into ingot moulds. Additions of oxide and limestone are now charged into the furnace, and then molten pig metal, equal in quantity to the finished steel tapped off, is poured into the furnace. A very vigorous reaction at once takes place between the impurities in the metal introduced and the oxidising slag, whereby the C, Si, P, and Mn are rapidly oxidised, and equivalent amounts of iron are reduced from the oxide in the slag, and pass into the metal bath. In working hematite metal, or metal low in phosphorus, the heat of the furnace is maintained as high as possible, as then the carbon and silicon are much more rapidly eliminated. On the other hand, when working high phosphoric irons, the temperature of the furnace is reduced as low as possible, consistently with maintaining the bath of metal in a fluid condition. Under these conditions, the phosphorus is eliminated before the carbon, and the highly phosphoric and silicious slag can be poured off, and fresh basic and oxidising agents added to form a pure finished slag, and so rapidly remove the carpon. Silicon is so rapidly removed that a few minutes after charging the molten pig metal, even when using large additions, equal to one-third of the bath, the metal in the furnace contains only traces. The ease with which the slag can be removed enables a very irregular metal to be used, as if the slag should be very silicious, it can be poured off before it can seriously attack the lining of the furnace. By the device of keeping the furnace hearth always two-thirds full of molten metal, the fluxing action of the slag on the basic lining is confined to a few inches above the bath of metal on which it floats, as it never comes near the bottom of the furnace, except when the furnace is being emptied at the end of the week. Thus a slag which, in the ordinary method of working the Siemen's process, would almost destroy the bottom of a basic furnace, has no appreciably destructive effect on the lining when the furnace hearth is protected by a bath of molten metal.

The work abounds in hints of value to the practical man. Take for instance the following on running stoppers when steel is being cast into ingots: Ingot moulds must not be filled too rapidly, or they will rise and "pipe"; and, on the other hand, if teeming is done too slowly, there is a very fair chance of never filling them at all, as the metal will probably set round the nozzle of the casting ladle. Sometimes a small piece of metal setting in the edge of the nozzle outside will divert the stream from the vertical, and cause it to splash on the sides of the ingot moulds, but generally a sharp-pointed bar and a skilful man will remove this. In the event of a running stopper—*i.e.*, a stopper which refuses to shut close—little can be done except to move the ladle as rapidly as possible from mound to mould, and to see that the pitmen remove the scrap from the top edges of the moulds the moment they can get near. In the case of metal partially setting in the nozzle, it may often be removed by one man holding a sharp-pointed bar, with the end bent up at right angles, under the nozzle, while another drives it into the nozzle with a sledge, and then rapidly knocks it out again. This is one of those practical things which must be done very quickly and skilfully if it is not to do more harm than good, and is a distinctly dangerous operation for a clumsy man to attempt. If this is not successful the only thing to do is to remove the nozzle-box on the bottom of the ladle, and knock the nozzle out, when the steel must be caught in the moulds as best it can. This is rarely successful, and frequently ends in spoiling several moulds by covering them with molten steel, and it is generally better to tip the ladle and pour the steel into one corner of the pit.

Or again—this time on the subject of gas producers: —Nothing is probably of greater importance in fuel economy than keeping a regular and systematic check upon the working of the producer by frequent analyses of the coal used, the ashes, and the evolved gas, as it is

not an uncommon thing to find producers working under similar conditions as regards fuel varying in efficiency from 50 to 60 or 75 per cent., which means that one producer is burning 70 tons of fuel to produce the same amount of heat as the other is producing from only 50 tons. In some American works, samples of gas are taken from the producer once or twice every twelve hours, an average sample from the main gas culvert every two hours, and the whole results tabulated and plotted each week. The cost of this is only equal to a few tons of fuel per week, and, if this example, combined with frequent analyses of ashes, etc., were followed in all our English works, the saving in fuel would probably astonish some of our steel makers.

Under normal conditions of work, when an average amount of steam is used, as in the Siemens, Wilson, or Dawson type of producers, carbonic acid should average about five per cent., and should never exceed seven per cent. A higher percentage than this, especially if the gas has a high temperature on leaving the producer, may be taken as a sure indication of bad working.

Mr. Hall's section is also intensely practical and to the point. A useful feature is included in the shape of bibliographies, so that those who wish to look further should have every opportunity of doing so. Mention should be made of the excellent series of photo-micrographs. There are many valuable pages concerned with micro-structure, special steels, testing specifications, etc.

"BRITISH INDUSTRIES UNDER FREE TRADE."

Essays by Experts.—Edited by Harold Cox, Secretary of the Cobden Club. T. Fisher Unwin. 6s.

Have British industries flourished under free trade? The question goes to the heart of the fiscal controversy, and in stating the case for free trade, an attempt is made to answer it by collecting the opinions of a certain number of practical business men, each of whom deals with the industry which falls within his own particular sphere.

Mr. M. L. Davies (of Messrs. Alfred Holt and Co.) deals with "Shipping Liners," and Mr. Walter Runciman, jun., M.P., with "Tramp Shipping." The Iron and Steel Machinery and Engineering, and Coal Trades are respectively called upon for evidence by Messrs. Hugh Bell, Arthur Wadham, A.I.Mech.E., and D. A. Thomas, M.A., M.P. The remaining industries discussed are the "Cotton Industry," by Mr. Elijah Helm; "The Woollen Industry," by Sir Swire Smith; "The Linen Industry," by Sir R. Lloyd Patterson; "The Silk Trade," by Mr. Matthew Blair (chairman of the Incorporated Weaving, Dyeing, and Printing College of Glasgow); "The Development of British Banking," by a Practical Banker; "The Cutlery Trade of Sheffield," by Mr. Frederick Callis; "The Tinplate Trade," by Mr. W. Llewelyn Williams, M.A., B.C.L.; "Confectionery and Preserve-making Industries," by Mr. Robert Just Boyd; "The Grocer's Industry," by Mr. J. Innes Rogers; "The Paper Trade," by Mr. Albert Spicer; "The Alkali Industry," by Mr. Alfred Mond (of Messrs. Brunner, Mond and Co.); "The Soap Industry," by Councillor A. H. Scott; "The Boot and Shoe Trade," with a "Note on the Leather Trade," by John T. Day (editor of the "Shoe and Leather Record"), and "Flour Milling Under Free Trade," by Mr. Andrew Law (of Messrs. Crawford and Law, Glasgow).

These essays should be read impartially by free trader and protectionist alike. The authorship alone stamps them with authority, and when we add that they are thoroughly readable, it will be understood that they are on a higher plane than much of the "literature" on the fiscal question with which the public has lately been assailed.

"LABOUR AND PROTECTION."

A Series of Studies. Edited by H. W. Massingham. T. Fisher Unwin. 6s.

Here again we have a collection of essays designed to proclaim the benefits of free trade. Mr. John Burns, M.P., leads off with "Political Dangers of Protection," in good fighting style, and his argument has much that is at once pungent and instructive. Though we do not wish to enter into political matters, we cannot refrain from quoting the following, which gives a good idea of Mr. Burns' "straight from the shoulder" style:—

"England has more than its equitable share of the world's work, and the pity of it is that so much of the product of its energies should be wasted in war, where it is not misspent upon drink or gambling, betting and luxury. A nation that spends £180,000,000 a year on drink, £70,000,000 on war, and £50,000,000 on horse-racing and betting need not tax the food of its poor or exclude the cheap sugar of foreign countries because it wishes to raise a few millions of revenue, or to help its Colonies. Here, in three branches of its wasteful expenditure—drink, war, gambling—lies the total amount of its export trade with the Colonies and the world. Here is a true margin for economy. Within these bloated figures are the means of Old Age Pensions, extended trade, diminished burdens, increased health, vigour, and capacity for all classes of the community."

The remaining essays make interesting reading, and are grouped under the following suggestive headings:—"Protection as a Working class Policy," "In the Days of Protection," "The Workman's Cupboard," "The Co-operative Housewife," "The People on the Margin," "Protection in the Staple Trades," "An Object-Lesson from Germany."

"THE CYANIDE PROCESS OF GOLD EXTRACTION."

A Text-book for the use of Mining Students, Metallurgists, and Cyanide Operators. By James Park. Third English edition, revised and enlarged. With frontispiece, plates, and illustrations. Charles Griffin and Co., Ltd. 7s. 6d.

This well-known handbook has now reached its third English edition. It is an authorised text-book in use in the Australian Schools of Mines, and it should be stated that the first English edition was revised and enlarged from the third edition published in New Zealand. The author has taken the opportunity of adding some valuable data relating to the lead smelting of gold slimes, the treatment of sulpho-telluride ores and filter press practice. Special mention should be made of the numerous folding plates, which are of the highest possible interest to students of cyanide practice. The frontispiece shows a mammoth cyanide plant in use in the Transvaal.

ANALYSES OF BRITISH COALS AND COKE.

The Colliery Guardian Company, Limited, 30 and 31, Furnival Street, London, have just issued the third part of a series of analyses of British coals and coke, which is appearing in the columns of the "Colliery Guardian." In collecting these analyses the object has been to classify them in districts over the coalfields of Britain, and they should prove of great value to those connected with the trade, either in a productive or in a commercial capacity.

OUR DIARY.

February.

22nd.—Great loss of life and destruction of several villages in China, consequent upon the bursting of a dam across the river Hwange-ho.—Navy Appropriation Account 1902-3, issued as a Parliamentary paper.

23rd.—Compared with the corresponding period of last year, the Cape Colony revenue returns for the seven months of the financial year show a decrease of £700,000.

24th.—The Egyptian revenue 1903 amounts to £E 12,463,700; the expenditure £E 10,595,979, which includes for the first time the charge of the reservoir annuity, half of which, £E 75,648, was paid in 1903.

25th.—*Lake Michigan*, the steamer which was recently beached near Dover is refloated and towed into the Thames.

26th.—A destructive fire occurred at Rochester, New York State, estimated damage from five to seven million dollars.—Fifteen thousand men employed by the Buenos Ayres and Rosario railways go on strike.

27th.—A notice to workmen placed in certain Government dockyards explaining the premium system of payment for labour which is to be introduced experimentally at an early date.—Messrs. R. P. Houston and Co. establish a weekly service of steamers between Manchester and Hamburg.

29th.—Annual Conference of the South Wales Miners' Federation opens at Cardiff.—The New South Wales revenue for the past eight months amounts to £7,368,518.—The Buenos Ayres and Rosario Railway Companies refuse the strikers' demands; goods traffic is paralysed.

March.

1st.—The Inter-Colonial Council opens at Johannesburg to reconsider the financial position of the Transvaal and Orange River Colony in view of the declining railway receipts.

2nd.—Inauguration of a new steamship service between Glasgow and New Zealand ports by the Tyser Line.—Members of the Motor-Van and Wagon Users' Association hold their first general meeting.

3rd.—Launch of the new cruiser *Argyll* at Greenock.—Issue of a Blue-book relating to the Transvaal Labour Question.—Launch at Belfast of a four-masted steamship for the Bibby Line.

4th.—The strike among the Argentine Railway employees seems likely to extend.

5th.—Lord Chelmsford presides at the annual meeting of the United Service Institution.

9th.—The decision of the Inter-Colonial Council, Johannesburg, to reduce the capital expenditure on the open railway lines by £170,000, entails the suspension of work on the four lines under construction.—A French steamer founders off the coast of Cochin China—over a hundred lives lost.—The newly reconstituted Coal Conciliation Board meet under the presidency of Mr. Alfred Hewlett.

10th.—The national conference of coal miners of Great Britain, meeting at Westminster, unanimously resolve "to continue to protest against the tax on exported coal until the tax is repealed."—Mr. Roger Wallace presides at the annual meeting of the Automobile Club.—In the House of Assembly, Cape Colony, the Treasurer, making a provisional Budget statement, anticipates a deficit of £429,000 for the current year.

11th.—Labour Importation Ordinance receives the Royal sanction.—The Miners' Conference passes resolutions against the introduction of Chinese labour into the Transvaal, and the employment of foreign labour in British mines.

14th.—The Prince of Wales witnesses some manœuvres of submarines, destroyers and battleships off Sandown.

15th.—The Belgian Government place the installation of wireless telegraphy on board the Dover and Ostend boats at the disposal of the passengers.—A Select Committee of the House of Commons meet to consider a Bill sanctioning the rebuilding of Southwark Bridge at an estimated cost of £480,000.

16th.—The Institution of Civil Engineers holds its annual dinner in Lincoln's Inn—Sir W. White presiding—address by Mr. Arnold-Forster.—It is announced that the German Steel Trust is to negotiate with British and American steel companies with a view to obviating the existing competition.

17th.—Prince and Princess of Wales witness an exhibition of torpedo work by the Vernon Torpedo School at Portsmouth.—Lord James of Hereford consents to continue the Chairmanship of the Coal Conciliation Board.—Sir Hiram Maxim gives a demonstration of his new "captive flying machine" at Thurlow Park, Norwood.—The Argentine Railway Strike terminates.

18th.—The British submarine A 1 is run down by a liner off the *Nab*, near Portsmouth—eleven lives lost.

19th.—Inauguration of the first section of the new Greek railway from Piræus to Demerli.

20th.—The American liner *New York* and the troopship *Assaye* in collision off the Isle of Wight.

21st.—Issue of Parliamentary paper giving full text of the regulations governing the recruiting of Chinese labourers.

NEW CATALOGUES AND TRADE PUBLICATIONS.

The Valor Company, Ltd., Rocky Lane, Aston Cross, Birmingham, forward descriptive circulars, illustrating their "Reform" and "Perfection" oil heating stoves, and the "Valor" perfection stove trays.

Bertrams, Ltd., St. Katherine's Works, Sciennes, Edinburgh, send us their new sheet of illustrations of machine tools for shipyards and iron constructional works. A pocket price list, containing a great deal of useful information in small compass, has also been issued by this firm.

J. J. Stockall and Sons, Ltd., forward a pamphlet which invites us to "Stop and Think." The interior is devoted to a short talk on method, the Stockall time recorder, check machine, and watchman's detector, etc. In the back cover is fixed a postcard, which can be detached and forwarded to the firm by those in search of further information.

Thomas Broadbent and Sons, Ltd., Huddersfield.—A good deal is said from time to time about the excellence of American printing, but we doubt whether our transatlantic friends could turn out better work than the pamphlet on cranes, which has just been issued by this firm. The salient facts regarding the numerous cranes illustrated and described can be obtained in a few minutes. A further reference to this pamphlet will be found under "Catalogue Cover Designs."

Bullivant and Co., Ltd., London.—This firm has issued an attractive reprint of articles on recent ropeway systems, which they have constructed in the Anaimalai Hills (conveying timber), at Queensferry, Flint (conveying coal and depositing over a given area), and at Wylam-on-Tyne, for Newcastle and Gateshead Waterworks. The first of these originally appeared in PAGE'S MAGAZINE. There is an exceedingly attractive display of half-tone blocks, those on the cover being especially noteworthy.

Gibbons Bros., Ltd., Dudley, London and Manchester. — A well printed and illustrated list of elevating and conveying machinery reaches us from this firm. The illustrations are mostly from photographs of machinery in actual use, and cover a wide range. Attention is particularly drawn to the construction of the Gibbons' patent steel roller chain. This minimises the wear on the connecting pins and links, thereby increasing very greatly the life of the chain.

The Rubber Stamp Company, Erdington, Birmingham. — We have received from this firm a very complete net price list of rubber endorsing stamps. This includes a large selection of useful commercial stamps. A special list of stamped brass letters and figures has been compiled for the benefit of engineers and iron founders. These are affixed to the pattern by ordinary pattern-maker's shellac or glue, or by brads through holes in the flanges. The catalogue includes particulars of technical diagram stamps, automatic numbering machines, perforating presses, ink pads, etc. The firm also issue a useful list of solid rubber type, which should be obtained and filed for reference.

W. R. Renshaw and Co., Ltd., Stoke-on-Trent. — "A few types of Rolling Stock manufactured by W. R. Renshaw and Co., Ltd., Phœnix Works, Stoke-on-Trent" is the title given to this brochure, in which two dozen art sheets are bound up. The first illustration is that of a 30-ton all-steel bogie wagon, as built for the Caledonian Railway Company. Among others we notice an all-steel explosive oil-tank wagon, built to the latest requirements of the railway companies; a tarpaulin-covered wagon, for lime, stone, cement, etc.; a 30-ton refrigerator car, built to the Cape Government Railway's requirements; a 10-ton coal wagon, with "Accessible" type side doors; a 10-ton shipping wagon, fitted with Simpson's patent End Door catch; a 12-ton all-steel wagon, for carrying hot billets, rails, etc.; a 10-ton cattle van, as built for the Brecon and Merthyr Railway Company; contractors' tip wagons; and a steel-frame steel tank wagon to carry 20 tons of oil—altogether a very interesting and instructive collection.

Horace P. Marshall and Co.—An illustrated list of labour-saving foundry machines, including pneumatic hammers, sand rammers and moulding machines, hand-press moulding machines, plate moulding machines, core making machines, "Acme" roots positive pressure blower, pneumatic screen shakers, etc.

The Electrical Mining Company, Ltd., Derby.—Miners who are adopting electrical plant should obtain this company's 1904 pamphlet, which has some reading and illustrations interesting to practical men. In the course of an introductory note the company claim that the whole of the articles illustrated and described are the result of many years' experience of mining requirements, and may be relied on to give the maximum efficiency consistent with strength, durability, and, above all, safety. The company is confident that the day is not far distant when we shall see collieries fully equipped electrically; the steam plant consisting of winding engines, a fan engine, and electric power station, all within a few yards of the boilers, the auxiliary machinery being driven by electric motors, with the result of reduced attendance and higher efficiency all round.

Dean, Smith, and Grace, Ltd., Keighley. — One of the best machine tool catalogues that has lately reached us bears the name of this firm. It is devoted entirely to lathes, and includes an interesting description of the high-speed lathes to which the firm has given special study for a considerable time. The catalogue has an artistic embossed cover.

The British Thomson-Houston Company, Ltd.—This firm has issued a useful little pamphlet entitled, "Hints to users of Electric Light on the best means of securing Maximum Light at Minimum Cost." From this firm we have also received pamphlet No. 164, containing an illustrated description of their type H transformers.

MR. ROBERT KAYE GRAY,
President of the Institution of Electrical Engineers.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining and Allied Industries.

VOL. IV. LONDON, MAY, 1904. No. 5.

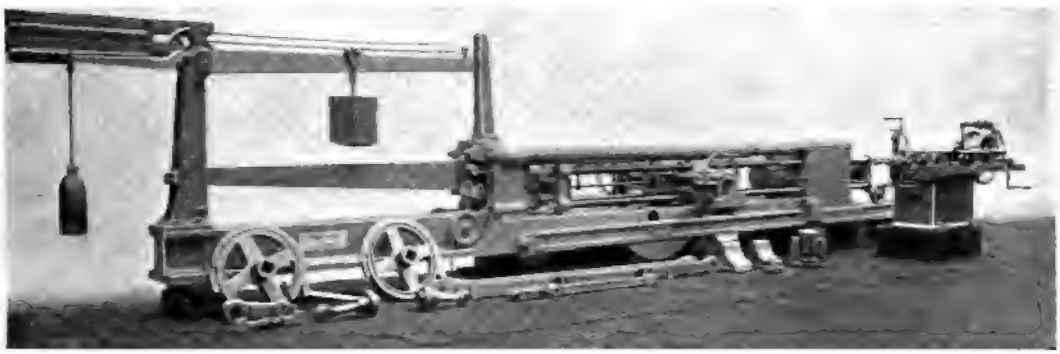


FIG. 2. 120-TON HORIZONTAL TESTING MACHINE BY MESSRS. GREENWOOD AND BATLEY, LTD.

TYPICAL ENGLISH TESTING MACHINES.

BY

A. FRANCIS.

This and the following article offer a powerful argument for the wider adoption and use of testing machines, which, as the author points out, not only enable the engineer to determine the strength of materials but also to obtain his supply in the most favourable market to specification.—ED.

PART I.

IT is not many years since machines for testing the strength of materials were considered expensive luxuries by English engineers, and consequently were rarely met with in the shops of medium and small-sized firms, whose proprietors would not believe that the cost of a testing machine would effect sufficient economy to warrant its installation. At that time it was usual to find draftsmen assuming that cast iron had a strength equal to that given in their favourite text-book, irrespective of the actual strength of the iron cast in their employers' foundry, which, for all they knew to the contrary, might have a tensile strength of anywhere between 5 and 12 tons per square inch. The natural consequences were that parts were often too light or absurdly heavy.

In the same way, rolled bars were ordered from the rolling mills or merchants and specified for as "merchant," "best," "best best," etc., and the only tests made were by nicking and cold bending. Nowadays it is exceptional to find a firm of mechanical engineers of any pretensions to importance whose equipment does not include machines for testing the tensile strength of iron, steel, bronzes, etc., as well as the transverse strength of cast iron.

There cannot be any doubt but that the few hundred pounds required to put down such machines is money profitably invested, for it not only enables the engineer to determine the strnegths of the materials he uses, but it permits him to obtain his supplies in the most favourable market to specification.

It is not sufficient for the buyer to specify the tests which the material should pass; it is also quite as necessary to see that samples fulfil the requirements as it is to ascertain that the count or weight is correct. No firm would think of passing an invoice for payment before the count

or weight had been duly checked by the storekeeper, and the quantity or weight is surely not of more importance than the quality. English designs of commercial testing machines vary widely from those of other countries: with few exceptions the principal English machines have long levers, with heavy poise weights and knife edges comparatively long distances apart. American testing machines usually have a multiplicity of levers of high ratio, and, consequently, small poise weights on short steelyards: whilst German machines such as the Werder, the Grafenstaden, and those of Mohr and Federhaff have their knife edges exceedingly close together, so that, with simple or compound levers, only light poises are employed, or, in the case of the Werder, the scale pan is suspended from the end of a short lever.

In selecting types of English testing machines for the purpose of illustrating this article, the author has confined the selection as far as possible to commercial patterns in preference to machines specially designed for research work in technical laboratories.

At the present time the type of machine most in vogue in this country is the vertical single-lever machine, which can be arranged for tensile, compressive, crushing, and torsion tests. This class of machine was originally designed by Mr. Wicksteed, and built by Messrs. Joshua Buckton and Co., Ltd. Machines on the same general principle are also made by Messrs. Greenwood and Batley, Ltd., and Messrs. Tangyes, Ltd., a 30-ton machine by the former being shown in fig. 1.

It will be seen that the machine consists of a substantial standard with hydraulic straining cylinder at its lower end, and with the heavy weigh beam mounted on top of the standard: the poise weighs 20 cwts., and, as is usual with this type of machine, travels from one end of the weigh-beam to the other: when at the right hand of beam it counter-balances the long arm of the lever, and thus obviates the necessity of using a separate counterweight. The poise is moved along the weigh-beam by means of a screw, rotated by belt, and gearing from the hand-wheel, the transmission passing through a

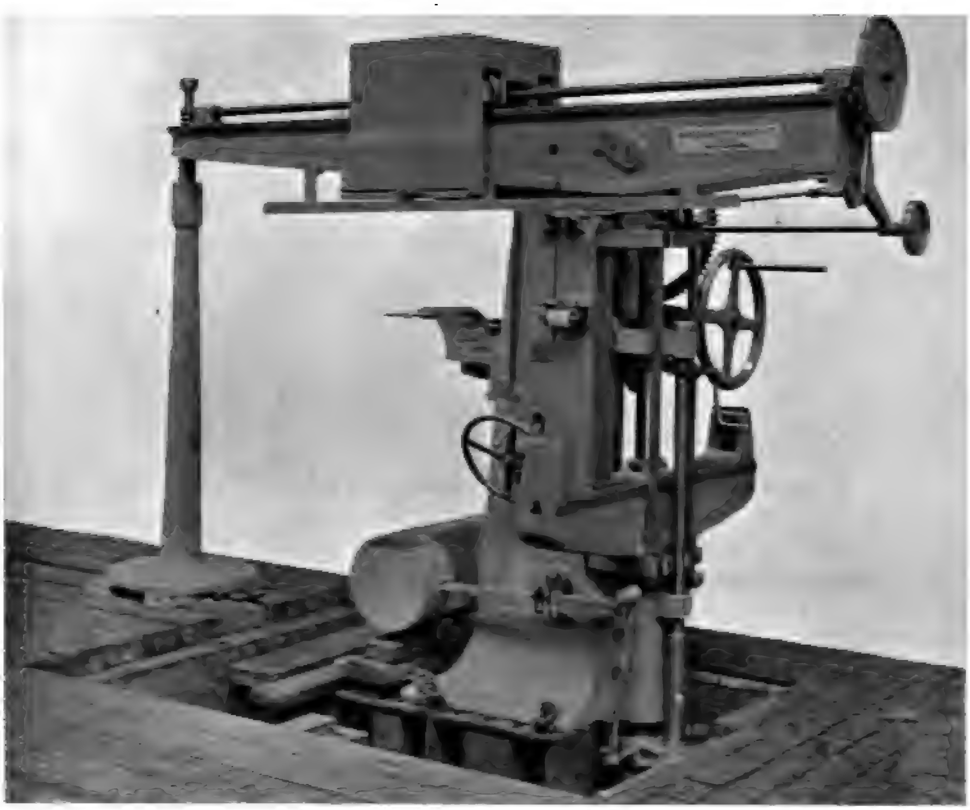


FIG. 1. VERTICAL SINGLE LEVER 30-TON MACHINE BY MESSRS. GREENWOOD AND BATLEY, LTD.

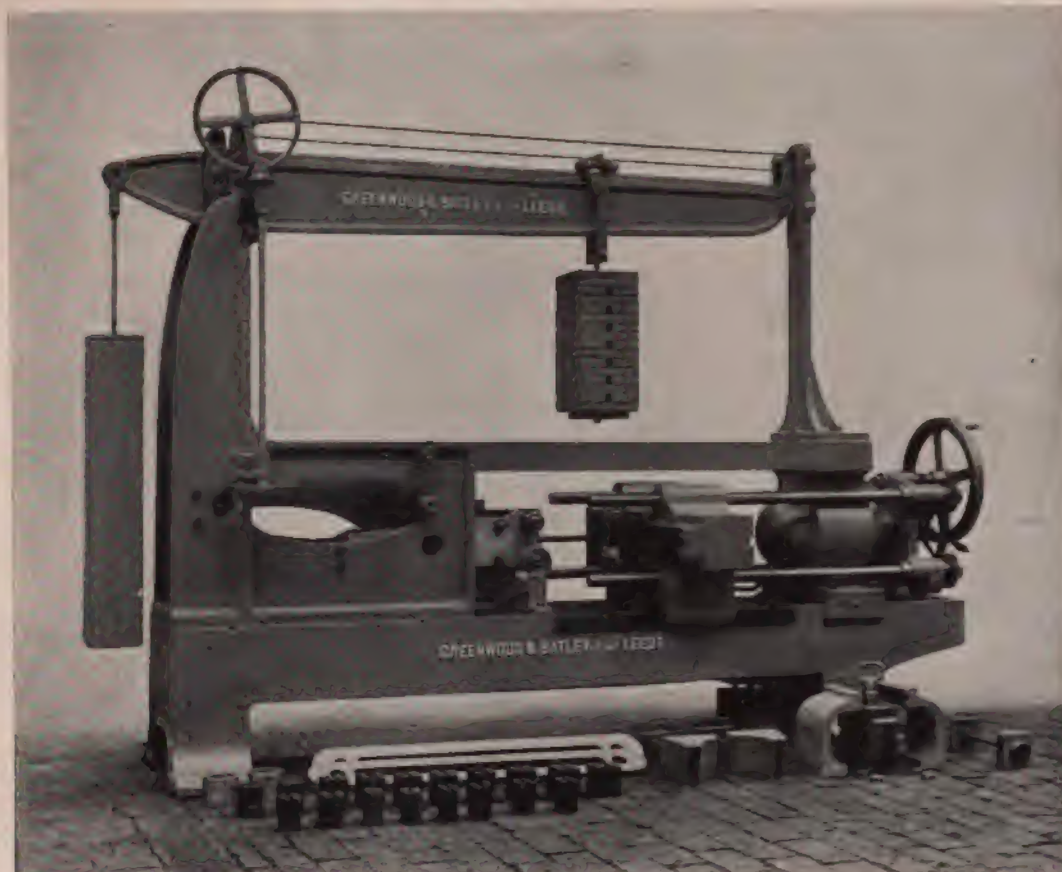


FIG. 3. A GREENWOOD AND BATLEY COMMERCIAL-PATTERN 50-TON MACHINE.

Hooke's joint in line with the axis of the principal knife edge. The load is read from a scale attached to the lever and by a vernier on the poise; the reading being in tons and one-hundredths of a ton. The lever is brought into equipoise by the position of the weight and the vernier is then adjusted to the zero mark on the scale; this is necessary every time the shackles are changed, or specimens of different weights are being tested. The photograph shows the machine fully equipped for tensile, compression, transverse, or torsion tests, and an autographic recording apparatus will be noticed on the side of the standard above the hand-wheel.

Figs. 2 and 3 are from photographs of two other patterns of the same firm's horizontal machines, the former being a machine of 120-tons power and the latter the Greenwood and Batley commercial pattern 50-ton machine. In both machines the scheme is the same, viz., a horizontal hydraulic ram applies a strain to the specimen which the latter transmits to the shorter end of a bell-crank lever, whose longer arm is connected by a link rod to the steelyard lever, which is counterbalanced by a pendant weight. The ratios of the combined levers in the two classes of machines are 250 : 1 and 100 : 1 respectively.

The method of loading the steelyard is a distinctive feature of the older Greenwood and Batley machines—a travelling monkey-carriage is propelled along the steelyard by a gut band, from the carriage hangs a weight pan upon which may be placed any desired number of flat weights representing certain values. The steelyard is not marked in tons or pounds, but in *proportions of leverage*, so that to arrive at the result of a test it is necessary to multiply the reading on the steelyard by the value of the weights on the monkey-carriage. Some engineers are very partial to this arrangement, because it enables the same machine to be used for widely different tests, as by using only a few weights a specimen of small size or low strength

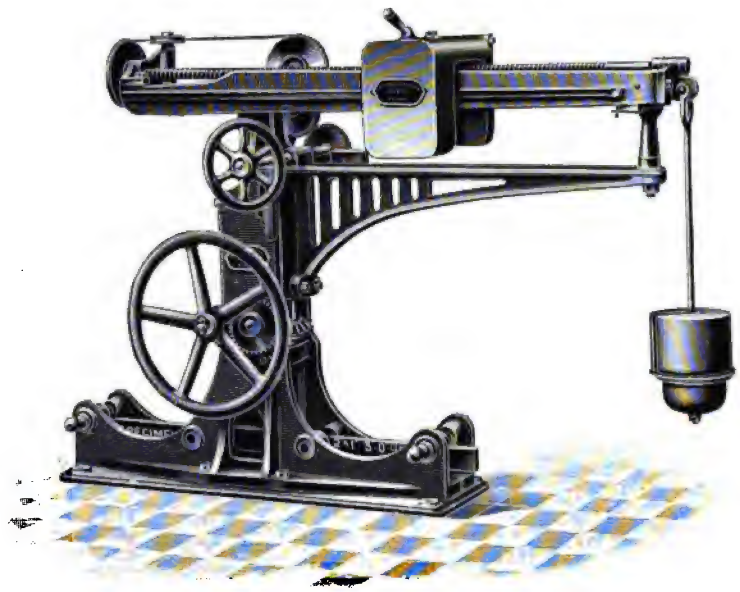


FIG. 4. 40-CWT. TRANSVERSE TESTER BY MESSRS. S. DENISON AND SON.

can be tested, and the extension noted across the full range of the steelyard, as against, perhaps, an inch or two of the scale if the test were being carried out on the type of machine shown in fig. 1. The horizontal machine has, however, the great disadvantage of being difficult to calibrate, whilst the vertical machine can have its accuracy easily tested by hanging heavy weights of known value from the shackle, and noting the reading of the vernier.

A pleasing exception to the majority of transverse testers is the small 40 cwt. machine of Messrs. S. Denison and Son. This is illustrated in fig. 4, and an inspection will reveal that the machine has been carefully thought out, and has had considerable attention bestowed on its design. This machine is arranged for the two standard sizes of test-bar, viz., 2 in. by 1 in. at 36 in. centres, and 1 in. square with 12 in. span. The load is applied by a screw, bevel gears, and hand-wheel, causing the bracket carrying the steelyard to rise vertically in a slide on the machine frame. The steelyard lever is connected to a shackle through which the test-bar passes, this exerting a bending stress in the centre of the specimen. The load is indicated by the position of the poise on the steelyard lever, which is engraved to give readings up to 30 cwts., whilst a weight to increase the total to 40 cwts. can be hung from the outer end of the steelyard. The movement of the poise is travelled by a screw and gearing, the pitch-line of the latter passing through the axis of principal knife edge: after a test the poise can be brought back to zero by a handle, which disengages the nut from the screw. In the author's opinion, it would be a distinct advantage if the steelyard gave direct readings up to 40 cwts.

A compact machine for testing materials in torsion, as made by Messrs. W. and T. Avery, Ltd., is shown in fig. 5. The capacity of this machine is 10,000 inch-pounds, and will admit specimens up to 12 in. long by 1 in. diameter. Between the specimens and the weigh-beam or steelyard are two levers so arranged that the ratio of leverage can be varied for testing pieces of high or low resistance.

(To be continued.)

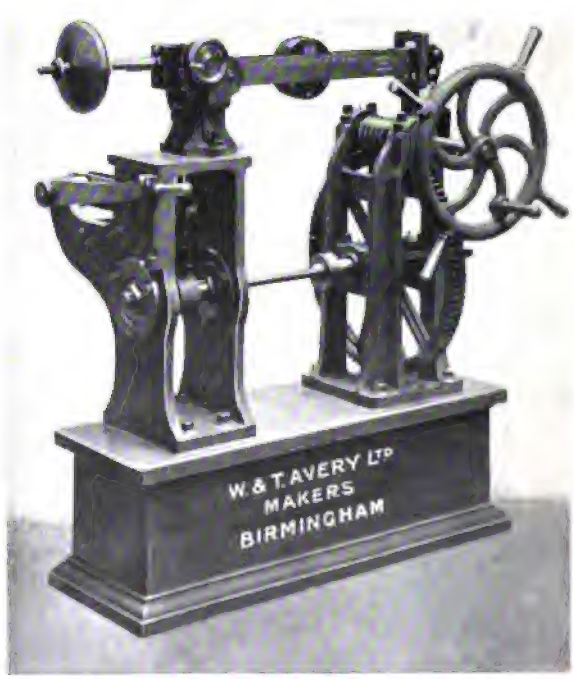


FIG. 5. MACHINE FOR TESTING MATERIALS IN TORSION BY MESSRS. W. AND T. AVERY, LTD.

The Electro-Capillary Recorder for Cable Purposes.

BY

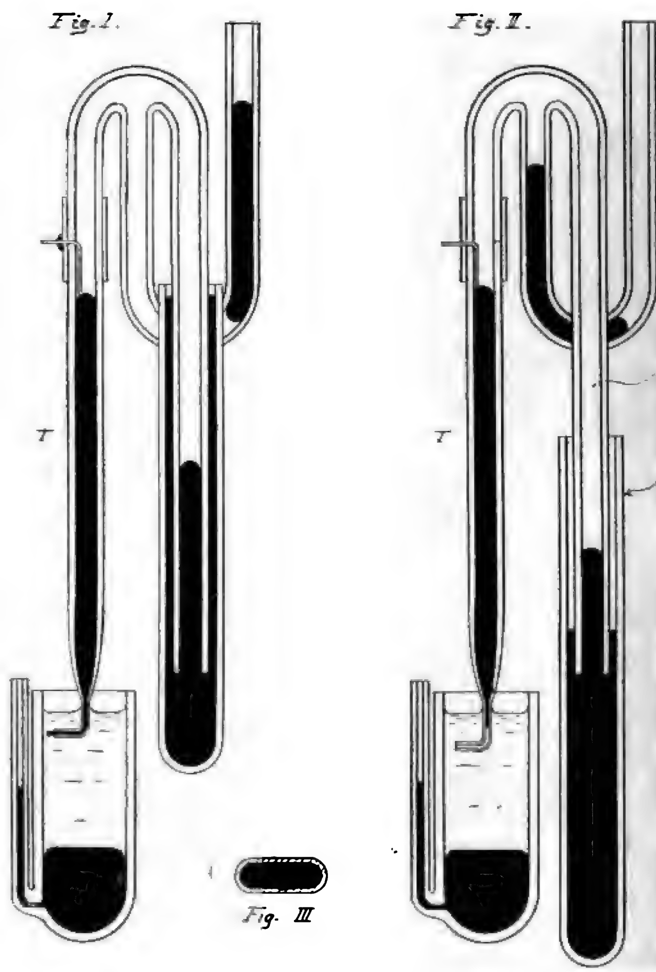
J. TARBOTTON ARMSTRONG AND AXEL ORLING.

The following notes deal with an instrument which it is confidently predicted will create a revolution in cable telegraphy, by accelerating the speed of reception, and effecting a great reduction in the cost of messages. Under proper conditions, the inventors claim that they are able to receive with their instrument messages at the rate of not less than four hundred to five hundred letters a minute.—Ed.

EVERYTHING relating to the cheapening of cabling and telegraphy is of the greatest importance to any and every country. It is doubtful whether the public fully realise the magnitude and serious character of the work that s accomplished by the establishment of submarine telegraph communication. Nothing is of more importance to the extension of trade and the bringing together of the ties which bind nations closely to one another than those silent messages which are constantly, almost momentarily, being dispatched to every part of the world by means of these submarine telegraphs, and there is no doubt that the spinal cord of civilisation would become severed if it were not for this means of international relationship.

Anything therefore that tends, even to a fractional extent, to the cheapening of cable or other telegraphic messages, materially influences political, diplomatic, financial, commercial, and social relations. There is no doubt that the extension ot the British cable system must in a great measure solve the vital problem of British Imperial federation—that great dream which is contemplated in the near future may become a reality. The more numerous the cables, the greater the degree in which the cost of messages can be reduced under British influence throughout the world, the more will British commerce extend, since there is no other means of so quickly creating new markets.

Questions of great moment in diplomacy



FIGS. 1, 2, AND 3. SHOWING MEANS OF ADJUSTMENT.

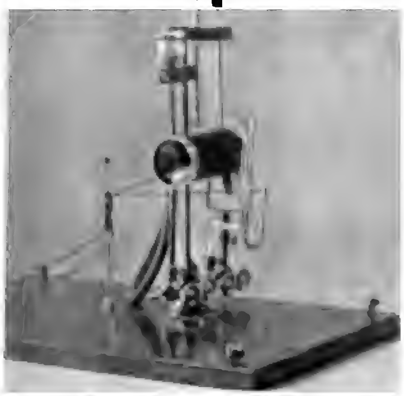


FIG. 4. THE FIRST ELECTRO-CAPILLARY CABLE RECORDER.

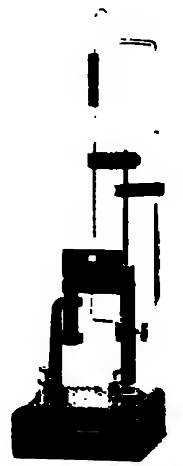


FIG. 5. ELECTRO-CAPILLARY RECEIVER FOR CABLE RECORDER.

FIG. 6. ELECTRO-CAPILLARY RECEIVER FOR DUPLEX TELEGRAPHY.

instead of taking, as they used to do, months to settle, are now adjusted in a few days: in fact, it is difficult to say what has not been revolutionised by the world's cables, for they not only assist in time of peace in the improvement and development of commerce, but in the time of war their usefulness is paramount.

The scientific organising and administrative ability of those in charge of the various cable companies is obvious and admirable, some of the best men of industrial enterprise being engaged in their promotion and control. Between twenty and thirty thousand men are at the present moment engaged in the various branches of cable work.

The electro-capillary phenomenon upon which the Armstrong-Orling Electro-Capillary Telegraphic Relay and Recorder are based was first observed by Kuhne. He found that when a fixed piece of iron wire touches the edge of the surface of a drop of mercury placed in dilute sulphuric acid (containing a small

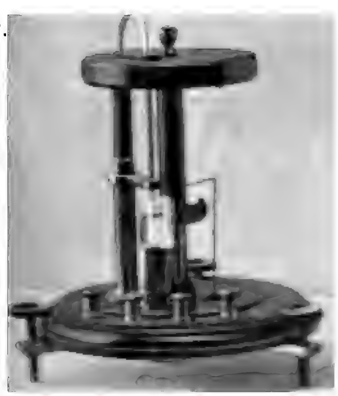


FIG. 7. ELECTRO-CAPILLARY RECEIVER.

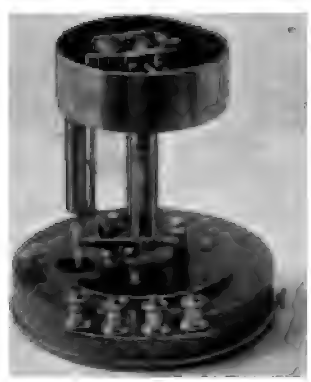


FIG. 8. ELECTRO-CAPILLARY TELEGRAPHIC RELAY.

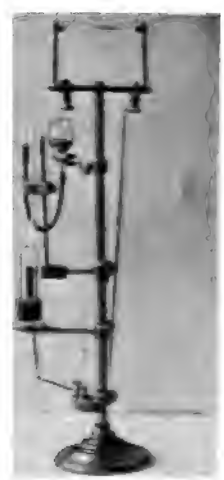


FIG. 9. ELECTRO-CAPILLARY RECEIVER FOR HERTZIAN WAVES.

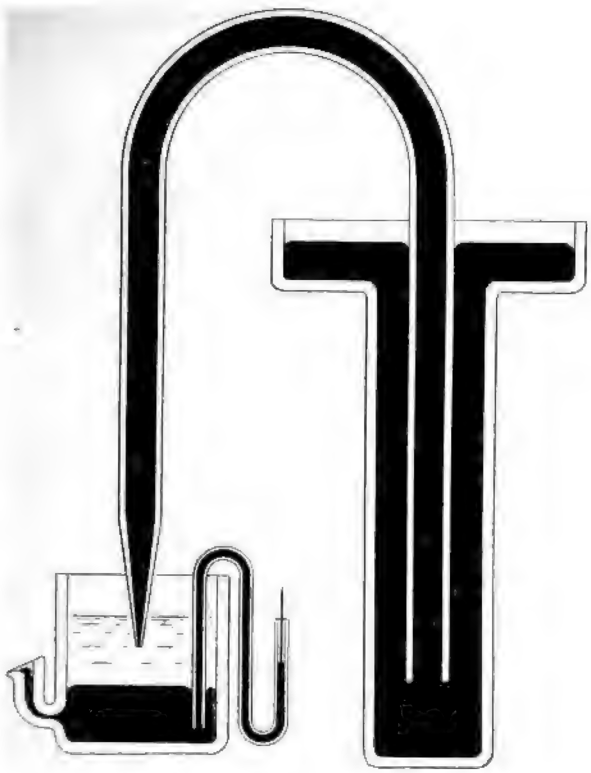


FIG. 10. ARMSTRONG-ORLING DROPPING ELECTRODE.

quantity of chromic acid) the mercury begins to vibrate.

An iron-mercury couple is formed when the contact is established between the two metals, which causes the surface of the mercury to be polarised by a layer of hydrogen. This polarisation increases the surface tension of the mercury, and causes the drop to assume a more spherical shape and thus breaks the circuit. The chromic acid depolarises the mercury, its normal shape is restored, the circuit is completed again, and this process repeats itself.

This phenomenon led Prof. Lippman to invent the electro-capillary electrometer, 1875. This electrometer consists of a glass tube, one end of which is drawn out to a fine capillary end, and is filled with mercury; this end dips into a vessel, containing dilute sulphuric acid and mercury. As terminals, platinum wires are fixed in the vessel.

If now a potential difference is set up, so that the mercury in the vessel is slightly higher than that in the capillary tube, the surface tension of the mercury in the latter is increased, and the meniscus of the mercury ascends.

Lippman found that the pressure required to force the meniscus back to its former position against a potential difference up to 0·6 volt is directly proportional to the difference of potential. This pressure he applied by means of an elastic bag, connected with the top and with a manometer, and used a screw to effect the required compression.

On account of its great sensitiveness, Maray employed this electrometer in his investigations of the functions of the electrical organ of the torpedo.

In 1882, Prof. Burdon Sanderson, by means of Lippman's electrometer, slightly modified by himself, proved that the closure of the leaf of the Venus fly-trap is accompanied by electrical changes.

Quite unaware of the experiments of Helmholtz in this field, Armstrong and Orling constructed dropping electrodes of various forms in 1898, which they applied practically in connection with Hertzian wave telegraphy.

For high-speed telegraphic recording purposes, they use an arrangement in which the meniscus lies in the path of a beam of concentrated light, which is thrown upon a sensitized travelling tape. The movements of the mercury, which are governed by the transmitted impulses, are thus recorded photographically on the tape. This instrument has now reached a

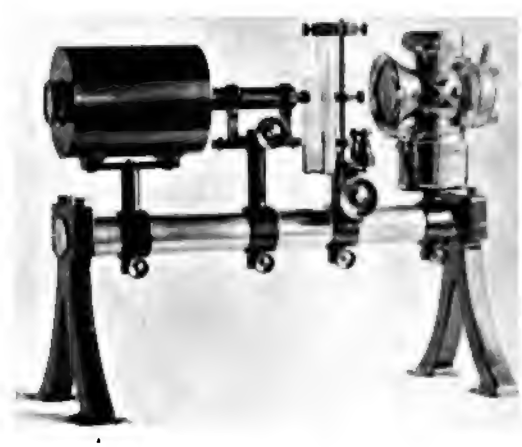


FIG. 11. THE LATEST CAPILLARY RECORDER.

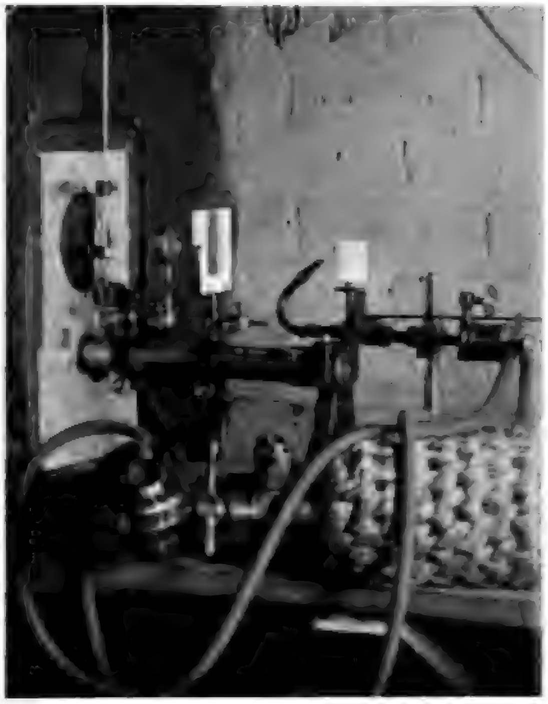


FIG. 12. THE ARMSTRONG-ORLING CABLE RECORDER WITH LIMELIGHT ATTACHMENT.

high pitch of perfection, and is the most suitable device for long cables or land lines.

This Capillary Recorder may be actuated by extremely small differences of potential, and owing to the small mass of the moving part (whose movements are to be recorded on the tape), and the consequently small inertia to be overcome by the electrical energy, responds almost instantaneously to any changes in the actuating potential difference. Hence its adaptability for long distance cable and other work. The Siphon Recorder, on the other hand, now so widely used for long cables, depends on an electro-magnetic field which is set up in a suspended coil (whose movements are to be recorded on a tape) by the current received through the cable, which causes it to move in a stationary field. The coil being several hundred times heavier than the moving part in the Capillary Recorder, offers considerable mechanical resistance to the small force that is to move it. Therefore the siphon recorder coil cannot respond so rapidly to electrical changes.

Authorities are of opinion that electrical energy rushes along a conductor with a velocity very much the same as that of light, but although some of the energy reaches the distant end of a cable almost instantaneously, the cable, having a high electro-static capacity, has to be charged before a potential difference sufficient to work the receiving instrument can be built up. It then takes time for such an impulse to die out. Therefore the more sensitive the receiver is to small changes of potential difference, the more suitable it is for long submarine cables, where high efficiency is wanted. Now it is said that if the receiver is too sensitive it would be too readily affected by outside disturbances and record unreadable signals. Such is the case with a slow working recorder whose curved recorder line has its signals comparatively far apart, but as the Capillary Recorder permits of a very high speed, the curves due to ordinary disturbances do not interfere enough with the actual signals to make them unreadable.

ONE OF THE DU BOUSQUET DE GLEHN COMPOUND LOCOMOTIVES.

OUR MONTHLY BIOGRAPHY.

MONSIEUR DU BOUSQUET,

Ingénieur en Chef du Matériel et de la Traction du Chemin de Fer du Nord.

MONSIEUR GEORGE DU BOUSQUET, whose name is so familiar amongst railway engineers, obtained his degrees as Mechanical Engineer at the Ecole Centrale in Paris, which he left in 1862, to become draughtsman at the works of the Northern Railway of France at Fives, near Lille.

MONSIEUR GEORGE DU BOUSQUET.

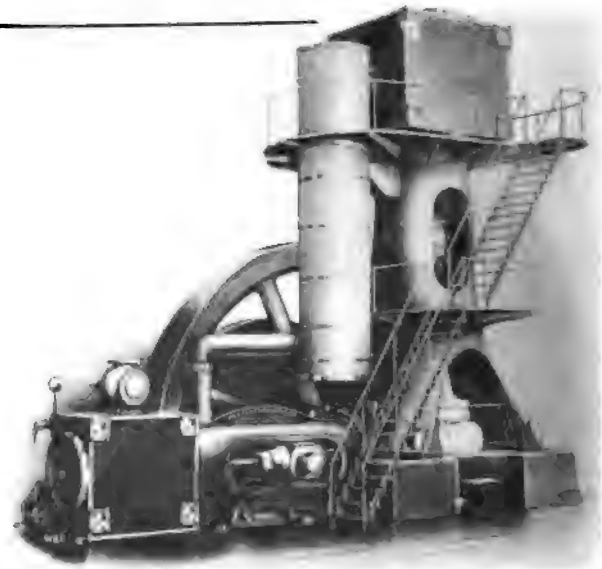
The late chief engineer of these works, M. Ferdinand Mathias, was not long in discovering that in M. du Bousquet he had an assistant of no small value, and this, no doubt, induced him to take a direct personal interest in the training of the young engineer. Seventeen years later, on the 20th October, 1883, when M. Mathias was appointed Locomotive Engineer of the Company in Paris, M. du Bousquet succeeded him as Manager of the Works at Fives, and in September, 1888, when the Chief Mechanical Engineer of the Company, M. Edouard Delebecque, was unfortunately killed by an engine whilst crossing the lines at La Chapelle, M. Ferdinand Mathias got the appointment of Ingénieur en Chef du Matériel et de la Traction of the company, and immediately called M. du Bousquet from Fives to Paris, with the title of Principal Mechanical Engineer of the Works at La Chapelle.

On the 19th September, 1890, M. Mathias having died M. G. du Bousquet was appointed to his present post as Chief Mechanical Engineer both for Locomotive and Carriage Departments. It is in that position that he undertook the heavy task of facing the constant demand made upon him of building engines of greater power and speed, both for passenger and goods trains. It is hardly necessary to recall the splendid performances of the du Bousquet engines on the Northern Railway of France and the magnificent corridor trains designed by M. du Bousquet, which are so much appreciated by the numerous travellers to Paris *via* Calais.

The most recent practical tribute paid to the genius of this distinguished engineer has been the introduction of one of his de Glehn compound locomotives into this country for use on the Great Western. This type of engine has been ably dealt with, in these columns, by Mr. Rous-Marten, who reverts to the subject in the present number (page 457). Its performances are, of course, being most carefully watched, and in the April issue of PAGE'S MAGAZINE it was shown that they have so far entirely sustained the opinions of those who were responsible for the experiment.

M. du Bousquet is Officier de la Légion d'Honneur, a distinction most deservedly bestowed upon him by the French Government in 1900.

POWER AT THE WORLD'S FAIR.



5,000-H.P. ALLIS-CHALMERS' ENGINE AND GENERATOR.

BY OUR ST. LOUIS CORRESPONDENT.

In previous issues of PAGE'S MAGAZINE we have dealt from time to time with the progress of the World's Fair. In the following pages will be found a brief account of those portions of the Exhibition which are more particularly interesting to engineers. The accompanying photographs were courteously furnished at our request by Mr. Mark Bennitt, Superintendent of the Exhibition Press Bureau.—ED.

IN the Palace of Machinery at St. Louis, and covering an area of 200,000 square feet—which is about the size of a city block—is the installation of engines, condensers, moving machinery, and other accessories, making up the 50,000 h.p. plant of the World's Fair.

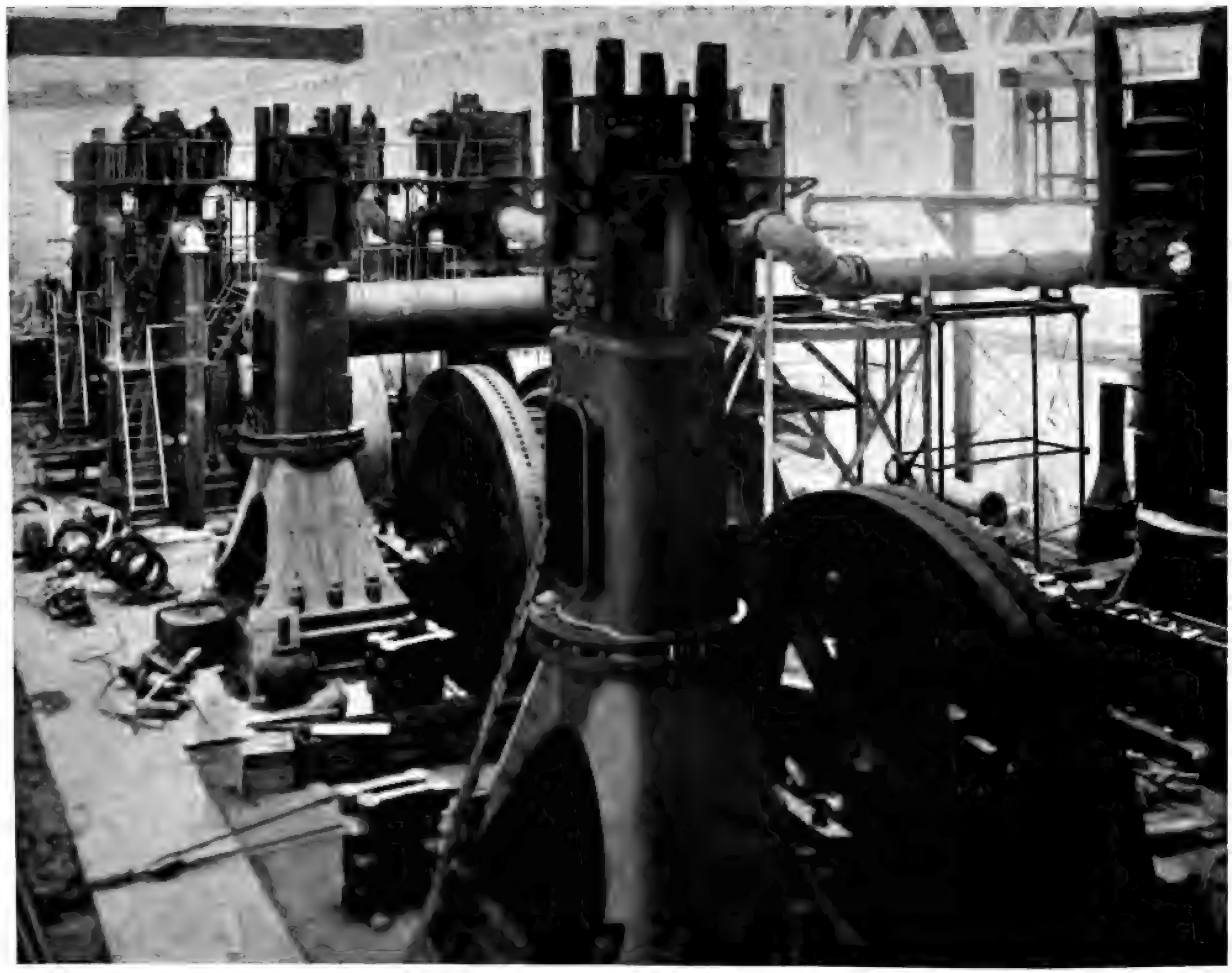
There is a 5,000 h.p. reciprocating vertical and horizontal steam engine, which, with its base, has a total height of 54 ft., 20 of this being depressed below the level, and the remaining 34 elevated above the floor. This engine and its generator weigh over 500 tons, and their value approximates $150,000. There is a 1,750 h.p. gas engine from Tegel, Germany; a 600 h.p. high-speed engine from Harrisburg, Pa.; a 750 h.p. medium-speed steam engine from Cincinnati; and a 1,000 h.p. slow-speed steam engine from Burlington, Ia. There is a tangential water-wheel, from San Francisco, and a steam pump from Jeanesville, Pa., which causes the water-wheel to operate by forcing water through a pipe and nozzle at the rate of 1,200 gallons per minute. Under a pressure of 300 lb. to the square inch, this great volume of water strikes the buckets of the wheel, transmits its energy, and falls as quietly as if poured from a basin. This water-wheel makes 900 revolutions per minute, is regulated by a speed governor from Boston, and a meter from Providence regulates the flow. There are a 3,000 h.p. gas engine from Seraing, Belgium; an 8,000 h.p. steam turbine from New York; and a 5,000 h.p. steam turbine from Pittsburg, Pa. In the Machinery Palace, near the western end, are also four 3,000 h.p. reciprocating steam engines, and three 80 h.p. exciter sets.

Such a line of prime movers has never before been brought together, yet this is but one of the three lines installed in the western half of Machinery Palace. The line of the north consists of steam engines largely of European build, and drawn from the greatest works in England, France, Germany, and Sweden. The line to the south, for the main part, is made up of gas and oil engines—the products of the great machine shops of the world. All types, speeds, and sizes are shown, from the little ½ h.p. gas engine for domestic use, to the great 8,000 h.p. steam turbine for the operation of lighting plants and trolley railroads.

The Belgian gas engine is a wonderful achievement.

3,000-H.P. WESTINGHOUSE GENERATOR—WORLD'S FAIR POWER PLANT.

PART OF BLOWER INSTALLATION IN STEAM, GAS, AND FUELS BUILDING—300 FT. BY 350 FT.



A LINE OF FOUR 3,000-H.P. WESTINGHOUSE GENERATORS AT THE WORLD'S FAIR.

No one has ever seen a gas engine of anything like 3,000 h.p. The same builders exhibited a gas engine of 600 h.p. at the Paris Exhibition of 1900, which excited more interest and comment than any other individual item at the Fair. Here we have one with five times the capacity of the Paris engine. Its fly-wheel weighs 34 tons, has a diameter of 28 ft., and its rim travels at the rate of nearly a mile and three-quarters per minute. A medium-sized horse can be driven through its cylinders, and its two pistons each travel 10 ft. at every complete stroke, making 100 strokes per minute each. About 30 tons of coal per day are consumed in the generation of the gas to operate it. The gas engines exhibited at the Chicago Exposition were mere toys compared to this engine.

One hundred feet to the west of Machinery Palace is found the Steam, Gas and Fuels Building, which covers an area of 100,000 square feet, and is a model fireproof structure. Here are mammoth hoppers for storing the 4,000 tons reserve supply of coal, and one can see the mechanical means for automatically conveying this coal from the cars to the bunkers, and from the bunkers to the furnaces and gas plants. The total length of the automatic conveyor lines is about three-quarters of a mile. The daily consumption of coal exceeds 400 tons. Here are found mammoth marine boilers from Germany and France, of the types used in the battleships of those countries. Gas producers to supply gas for the operation of the engines in the Machinery Hall are in this building, and there are various types of mechanical stokers, forced drafts apparatus, water purifiers, and other appliances germane to steam generation.

In its entirety, the power plant of the Exposition exemplifies and demonstrates the most modern practice as it obtains in the United States and in Europe.

PALACE OF MACHINERY AT THE WORLD'S FAIR, ST. LOUIS.
It occupies an area of 525 ft. by 1,000 ft. and contains the 50,000-h.p. plant of the Exhibition.

THE STORY OF THE CUNARD COMPANY.

BY

BENJAMIN TAYLOR, F.R.G.S.

In the previous article the early history of the Cunard Company was related. The author now records the unsuccessful attempts which have been made from time to time by various competitors to secure supremacy on the Atlantic, and deals with the most recent developments of the Company.—ED.

II.

THE formation of an American Combine, competing for the Transatlantic traffic, recalls the efforts which the Americans made in past years to secure a share of this trade. The Cunard Company were, of course, the first to establish a regular service of mail steamers between the Eastern and the Western hemispheres. This was, as we have seen, in 1840, but although they long enjoyed a practical monopoly, they were always exposed to occasional competition. There were "tramps" in those days, as in these.

THE FIRST ORGANISED OPPOSITION.

The first organised opposition, however, was of American origin—the Ocean Steam Navigation Company, formed in the United States in 1847. This Company had two steamers built—the *Washington* and the *Hermann*—and they contracted with the U.S. Government to carry the mails twice a month between New York and Bremen in return for a payment of £40,000 a year. The steamers were to call at Southampton on both runs, and the contract was worked out for a year, but was never renewed. The *Washington* was the first to run, and she left New York in June, 1847, for Southampton, on the same day that the Cunard steamer, *Britannia*, left for Liverpool. The Cunarder came in two days ahead of the American. The *Washington* was of 1,750 tons measurement, and 2,000 horse-power, and this is what a *Times'* reporter of the day (June, 1847) said about her, as he described her appearance in the Solent: "In point of size she looked like an elongated three-decker, with only one streak round her; but about as ugly a specimen of steamship-building as ever went through this anchorage. She did not appear to make much use of her 2,000 horse-power either, but seemed rather to roll along than steam through the water. She excited considerable curiosity, although her performance, as compared with the *Britannia*, had evidently taken the edge off the feeling with which the vessel would have been viewed had a different result been obtained in her favour."

This Ocean Steam Navigation Company is said to have been the first case in which national funds in America were applied to the support of private enterprise. Congress did not very readily grant the subsidy, and was only induced to give it as a helping towards the formation of a reserve marine force, which, in case of need, would be available for the protection of American rights. In the early contracts between the British Government and the Cunard Company for the conveyance of mails between New York and the Bermudas, there was a provision that the steamers should carry one or two eighteen-pounders. The *Washington* and *Hermann* were the wrong type of vessel. Their competition was not a success, and when the contract was up they were laid aside.

OTHER RIVALS—THE GUION LINE.

About this time a new opposition to the Cunard Company was the germ of the Guion Line. The Black Ball Line of sailing packets between Liverpool and New York was one of the most famous of its day and generation, and the managing owners of the Black Ball Line were C. H. Marshall and Co. The owners of these clippers were among the first to recognise that their days were numbered, and that steam would rule the waves in future years. About the year 1847, C. H. Marshall and Co. had a steamer called the *United States* built, to carry the Black Ball flag, and to secure some of the sweets of the Atlantic steamer traffic for their own line. She did not pay, and was soon taken off the service, but the Black Ball fleet was eventually united with the sailing fleet of Mr. S. B. Guion, who, about 1866, began to organise the regular service of steamers known as the Guion Line.

THE NEW YORK AND HAVRE STEAM NAVIGATIO COMPANY.

The next rival of the Cunard Company was the New York and Havre Steam Navigation Company, which also was a concern subsidised by the United States

A TYPICAL SCENE AT THE LIVERPOOL LANDING STAGE.

Government. This Company undertook a contract for fortnightly mails between New York, Southampton, and Havre for a subsidy of £30,000 per annum, but they began badly. Their first two steamers were wrecked, and two steamers they chartered, until new ones could be built, proved a loss. Finally, they got the *Fulton* and the *Arago* on to the run, but by this time the Collins Line was in full swing, and the New York and Havre Company disappeared.

The Americans were chagrined to see their supremacy on the Atlantic passing away, and the conveyance of mails and passengers becoming the monopoly of an English company—or rather a Scotch company, for what capital was in the Cunard Line was mainly Scottish. North American clippers were of no avail against steamers, and steamers could not be run with profit without Government subventions. This, at any rate, was the belief then, although the very success of the Cunard Company—at that time earning something like £7 10s. per ton freight on the goods carried by their steamers—proved the contrary. Moreover, the national pride of Brother Jonathan was aroused. He did not like the idea—apart altogether from profit—of his oversea, and even coast-mail, traffic being monopolised by the Britisher.

THE COLLINS LINE.

While the Cunard Company were expanding, American steamers were being launched in abundance on American rivers and lakes, and it was natural that a determined effort should be made to share the spoils of the Cunard Company, if not to run them off the face of the waters. The man for the occasion appeared in Mr. E. K. Collins, of New York, who had from boyhood been engaged in connection with clippers between that port and Liverpool. Mr. Collins saw all the profit disappearing in his packet business, and set to work to organise the Collins Line of steamers to replace the Collins Line of sailing packets. He had to secure the support of a number of American capitalists, and they were not disposed to move without promise of Government aid. The Government were willing enough to treat, and Congress was already committed to the principle of subsidies. The bargain was in fine made that Mr. Collins should provide five first-class steamers, sufficient for a service of twenty voyages per annum, and that he should receive 19,250 dollars, or £3,850, per voyage, from the Government. These were better terms than the Cunard Company started with—£55,000 per annum for a fortnightly service with three steamers. The Cunard subsidy was afterwards increased to £70,000 for four steamers, but there were certain stringent conditions as to sailing dates, the carrying of Naval officers, etc., which were very irksome. On securing the Government contract, Mr. Collins and his partners set to work to build four wooden steamers of 3,000 tons each, and 800 horse-power, steamers nearly three times the tonnage and twice the horse-power of the first four Cunarders. They were strongly built of oak, planked with pitch pine, strengthened with iron bands and fitted with all the latest improvements of their day. There is no doubt the *Arctic*, *Baltic*, *Atlantic* and *Pacific* were very superior vessels, remarkable not less for the beauty of their models than for the excellence of their construction, which cost 700,000 dollars each. Their dimensions were: Length of keel, 277 ft.; length of main deck, 282 ft.; depth from main deck, 24 ft.; breadth of beam, 45 ft.; launching draught aft, 10 ft.; area of loadline, 9,369·10 square feet; weight of hull, 1,525 tons; weight of spars and rigging, 34 tons; ordinary loadline, 20 ft. aft and 19½ ft. forward. They had each three masts, three decks and an orlop deck, and rounded sterns. The hulls were built by W. H. Brown and Co., of New York, and the engines and boilers were designed by Mr. Sewell and Mr. Faron, chief engineers of the U.S. Navy. As speed in excess of the Cunarders was required, cylinders of 95 in. diameter and 9 ft. stroke were designed—the *Britannia's* cylinder being only 72½ in., with a 6 ft. 10 in. stroke. The Collins' engines were on the side-lever principle, with cast-iron beams and wrought-iron columns and braces. The boilers were peculiar, and were the invention of Mr. Faron. The furnaces were constructed for bituminous coal, but after a while anthracite was used on the eastward runs. The diameter of the side-wheels was about the same in each of the four boats—viz., 35 ft., 35 ft., 35½ ft. and 36 ft. respectively.

LAVISH EXPENDITURE ON SPEED, COMFORT, AND ELEGANCE.

The *Arctic*, the first of the Collins' fleet, made the following average record with her engines: Pressure, 16·9 lb.; revolutions, 15·8 per minute; consumption of coal (anthracite), 83 tons per day; average speed, 316 knots per day. Her maximum record was: Pressure, 17·5 lb.; revolutions, 16·7 per minute; consumption, 87 tons; speed, 320 knots per day. The *Asia*, of the Cunard line, consumed 76 tons of coal on a run of 303 knots per day. The *Pacific* was the most popular of the Collins' fleet, because her great height above water, straight bows, and clear upper deck, made her more roomy and comfortable for passengers. The Collins Company aimed not only at speed—on which, indeed, the U.S. Government subsidy depended—but also at surpassing in comfort and elegance all provisions hitherto made for ocean passengers.

These were the first steamers to provide smoking rooms. They also provided dining saloons, in addition to the general saloons hitherto thought sufficient—apartments of 60 ft. by 20 ft., gorgeously upholstered and fitted with ornamental woods. With them began the era of Turkey carpets, marble-topped tables, gilded mirrors, painted panels, and costly lounges. They also inaugurated the barber's shop, that permanent and indispensable institution now in all well-appointed ocean liners. Naturally, therefore, the Collins' steamers excited a great deal of interest, even before the exciting series of races with the Cunarders had fairly begun.

But they cost much more money than was anticipated when the enterprise was started. Expenditure on hull, machinery, and equipment was lavish, and long before the fleet of four was completed the company had practically exhausted their capital, and had to apply to Government for an advance in anticipation of the subsidy. The company were relieved from the obligation to furnish a fifth steamer on guaranteeing a higher rate of speed than that at first stipulated for the four. There were to be twenty-six sailings per annum, and the subsidy was raised to 33,000 dollars per voyage. This made a total subvention of 858,000 dollars, or £171,600 per annum. But the probable effect of the enlarged competition on traffic was not kept in view, and one very pronounced effect was, that whereas the Cunard Company had been receiving £7 10s. per ton freight, soon after the Collins' steamers started the rate fell to £4 per ton.

The Collins Company claimed, and with some justice, that they cut off a day and a half in the voyage between New York and Liverpool. But the tremendous exertion cost them a million dollars per annum, which was not recouped by the stream of passengers they attracted from the Cunard boats—and in 1852 they really carried about one-half more than did the Cunard.

From 1850 to 1852 the Collins Line had the pull, but in 1852 the Cunard Company brought out the *Persia*, the largest and most powerful vessel as yet placed on the Atlantic, and two or three years later another steamer, with which they completed the conquest of the Collins Line.

MISFORTUNES OF THE COLLINS COMPANY.

It was not only competition which upset the Collins Company. Misfortune dogged their steps otherwise. The first crushing blow to the struggling undertaking was the loss of the *Arctic*—one of the first and saddest of the catastrophes of the Atlantic steam passenger trade. The *Arctic* left Liverpool for New York on September 21st, 1854, with 150 first-class passengers, 83 second-class, and a crew of 135 men—say 368 souls, all told. Six days later she was sixty miles off Cape Race. In a fog she collided with the French steamer *Vesta*, bound from Havre, with 147 passengers and a crew of fifty. At first the *Vesta* seemed to have had the worst of it. Some of her people scrambled on board the *Arctic* before she sheered off, others rushed to the boats, which, in the hurry, were swamped with all on board of them. Those who remained on the *Vesta* were saved, for she reached St. John's. The *Arctic* was badly hit somewhere below the water-line, and the water was making its way to the engine-room. She was at once headed round for Cape Race, but before she could make land the water reached the fires, and the ship went down. Of the boats which were hastily launched, only two were ever heard of again, and these succeeded in reaching the shore with fourteen of the passengers and thirty of the crew, including the captain and two officers who stuck by the ship to the last. Among those who went down with the *Arctic* were the wife, son and daughter of Mr. Collins, and numbers of persons of eminence in commerce and society on both sides of the Atlantic. The catastrophe caused a sort of check to the boom in ocean travel, and started a brisk discussion on the dangers of speed, the risks of cross-sea traffic, the build of steamers, and so on.

The excitement had barely died down, when a second terrible disaster befell the Collins Line, and gave a further fright to passengers. This time it was the *Pacific*, the pioneer and the most popular member of the Collins' fleet, although the *Arctic* was the fastest, and was esteemed the finest of the sisterhood. And the second catastrophe occurred within a year of the loss of the *Arctic*. The *Arctic* was lost in September, 1854. On June 23rd, 1855, the *Pacific* left on the same voyage—from Liverpool to New York—and was never heard of again. Her complement of passengers was much smaller than that of her unfortunate sister ship, viz., twenty-five first-class, and twenty second-class, with officers and crew numbering 141 besides—in all, 186 souls. She had the mails, and her cargo was insured for £500,000, but was doubtless worth a great deal more. How the *Pacific* was lost was never revealed. Not a soul was saved, and not a vestige of her was ever cast upon the bosom of the waters, or upon any lonely shore.

The loss of these two ships was a terrible blow to the Collins Company, but they set to work to raise more money in order to build two new steamers, to excel in size and speed and everything, not only the four first, but also the Cunard's *Arabia*. The *Adriatic* was the only one of the new additions which made any record. This new competition began in 1856, but it only lasted for two years. The Collins Company were running at a ruinous loss, and in 1858 the funds gave out. There was a strong effort to reconstruct the company with fresh capital, but a dead set against subsidies was made, and Congress refused to grant a renewal of them.

The collapse of the Collins Company removed American competition for the time being, but did not leave the ocean to the monopoly of the Cunard. American steamers of the Vanderbilt Line continued to run between New York and Havre, with varying success, until 1868.

THE INMAN LINE.

The fall of the Collins Line was the signal for the rise of the Inman Line. For some years the Liverpool, New York and Philadelphia Steamship Company, started by Mr. William Inman, had been running regularly between Philadelphia and Liverpool, but so long as the Collins and Cunard boats were racing each other for the New York traffic, the Inman boats did not interfere in that, and carefully avoided New York—at least, until the year 1857, which was just prior to the break up of the Collins Line. When that concern was fairly out of the way, Mr. Inman took up their sailing dates and sent his steamers regularly between New York and Liverpool, as well as between Philadelphia and Liverpool. The death of the Collins Line was thus the new birth of the Inman, and the Inman Company were the first to put on iron screw steamers for the Transatlantic traffic. To Mr. Inman belongs the credit of discovering that the propeller was the most suitable form of steamer for ocean service.

Mr. George Burns was created a baronet by the late Queen Victoria in 1889. He was then an old man, retired from business, and he lived only till 1890. Then he was succeeded by his son John, who was created first Lord Inverclyde in 1897, and died in 1901. It was he who organised the transfer of the business of the old Burns and MacIver firms to the Cunard Steamship Company, Ltd., which was registered in 1878 with a capital of £2,000,000, in shares of £20 each, of which 60,000 are fully paid and 40,000 have £10 paid on them. The first Lord Inverclyde was the first chairman of this company. His eldest son, the present Lord Inverclyde, is the second chairman, and it is he who has organised the recent new departure of the company.

THE CUNARD AND THE GOVERNMENT.

The acquisition by an American Combine under Mr. J. Pierpont Morgan of a number of British lines of steamers on the Atlantic led to negotiations between the Government and the Cunard Company, which resulted in an agreement intimated in a circular by Lord Inverclyde to the shareholders in the following terms: "I have now the honour to inform you that I have concluded negotiations with His Majesty's Government, on behalf of the Cunard Company. The following are the principal terms of the arrangement :—

"1. The Cunard Company are to build two large steamers for the Atlantic trade of high speed.

"2. The agreement is to remain in force for twenty years from the completion of the second of these vessels.

"3. The Cunard Company pledges itself, until the expiry of the agreement, to remain a purely British undertaking, and that under no circumstances shall the management of the company be in the hands of, or the shares or the vessels of the company held by, other than British subjects.

"4. During the currency of the agreement the Cunard Company is to hold at the disposal of the Government the whole of its fleet, including the two new vessels and all other vessels as built, the Government being at

PROMENADE DECK OF THE "CAMPANIA."

FIRST SALOON SMOKING-ROOM, "SAXONIA."

Liberty to charter or purchase all or any such vessels at agreed rates.

"5. The Cunard Company also undertakes not to unduly raise freights, or to give any preferential rates to foreigners.

"6. The Government are to lend the money for the construction of the two new vessels, charging interest at 2¾ per cent. per annum. The security for the loan is to be a first charge on the two new vessels, the present fleet, and the general assets of the Cunard Company.

"7. The Cunard Company is to repay the loan by annual payments extending over twenty years.

"8. From the time the new vessels commence to run the Government are to pay the Cunard Company at the rate of one hundred and fifty thousand pounds (£150,000) per annum, instead of the present Admiralty subvention.

"A meeting of the shareholders will be convened as soon as practicable for the purpose of obtaining their approval to such alterations in the articles of association as will be required to enable the directors to enter into a formal agreement embodying these terms."

According to the specifications issued by the Cunard Company the length of the new liners is to be 750 ft., or fifty feet longer than any vessel as yet afloat. The beam of 76 ft. is one foot greater than that of the largest of the White Star Company, and compares with 72 ft. in the *Kaiser Wilhelm II.*, 68 ft. in the *Oceanic*, and 67 ft. in the *Deutschland*. The new Cunarders will be of between 28,000 and 30,000 tons displacement, as against the *Celtic*, 20,904; *Kaiser Wilhelm II.*, 20,000; *Oceanic*, 17,274; and *Deutschland*, 16,502. In the German vessels the highest engine power is 40,000, enabling them to steam at an average speed of rather over 23 knots an hour. The Cunarders' *Campania* and *Lucania* have engines of 28,000 i.h.p. and a speed of 22 knots. The new liners will probably have engines of about 58,000 i.h.p., to attain a speed of 24 to 25 knots.

UPPER PROMENADE, "SAXONIA."

THE NEW SUBVENTION.

Concerning the amount of the new subvention, about which there has been a good deal of foolish talk on both sides of the Atlantic, it will be well to quote from the report of the Admiralty Committee appointed to inquire into the whole subject of merchant cruisers. They say: "We have inquired carefully into the initial cost of vessels possessing a speed of 20 knots and up to 26 knots, and also into the amount of annual subsidy which would be required by a commercial company towards making good the loss which would be sustained in peace time by running such vessels. These costs may be provided either by (1) the Admiralty guaranteeing a sum representing the first cost of each ship, thus enabling a shipowner to raise the capital at 3 per cent., instead of 5 per cent., which he would otherwise have to pay; (2) the contribution on the part of the Admiralty of a lump sum towards the first cost of the ship, thereby reducing the outlay on the part of the shipowner; (3) an annual payment extending over an agreed period of years. Adopting the principle of an annual payment, we subjoin in a tabular form our estimates of the first cost of ships having a speed of from 20 to 26 knots, and of the subsidy which we believe will be found necessary:—

Average Ocean Speed. Knots.	First cost, Building, &c. £	Engine Power, I.H.P.	Annual Subsidy. £
20	350,000	19,000	9,000
21	400,000	22,000	19,500
22	470,000	25,500	40,500
23	575,000	30,000	67,500
24	850,000	40,000	110,500
25	1,000,000	52,000	149,000
26	1,250,000	68,000	204,000

It is possible that hereafter the first cost of such ships and their running cost may be diminished to some extent by inventions for using oil fuel, turbine engines, etc., etc.; but for the present purpose these cannot be taken into consideration."

The subvention for the two new Cunarders is, therefore, just what the Committee estimated would be necessary to recompense *one* of the speed specified.

One difficult point to decide was, whether the new vessels should be propelled by two or three screw propellers. Two propellers would require four engines—two on each shaft, as in the case of the 40,000 i.h.p. sets of the new German ship *Kaiser Wilhelm II*. There is the difficulty of transmitting such an enormous power through two shafts. It means 25,000 h.p. for each, and although the Cunard Company's *Umbria* and *Etruria* have single screws with 14,000 to 15,000 i.h.p., it is a long step even from the German 19,000 to 20,000 to the 24,000 to 25,000 i.h.p. of the new Cunarders. In the German ship the shaft for each engine is 226 tons. The six-throw crank is of nickel steel, which has a breaking strain of 38·41 tons per square inch, with an elongation of 21 per cent., and weighs in all 114 tons. The propeller shaft is of crucible steel. The ingot for it weighed eighty tons, and was cast with the contents of 1,768 steel smelting crucibles, the operation occupying 490 men during thirty minutes. The alternative to two shafts is three screws, each with its own engine, which would divide up the power to about 17,000 i.h.p., but an arrangement requiring much more engine room, as three engines cannot well be placed in the width of the ship along with auxiliary gear. A special commission of experts appointed by the Cunard Company have just decided that the turbine should be adopted, and that four shafts and four sets of turbines should be preferred to three.

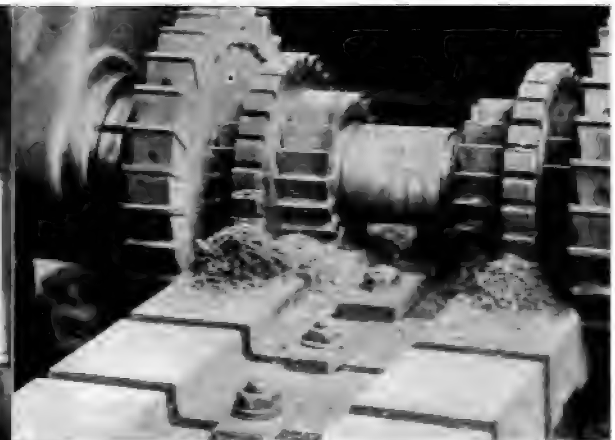
THE LATEST CUNARDERS.

There has been necessarily a good deal of delay in placing the contracts for these two mammoth vessels, concerning which Lord Inverclyde said in 1903 at the annual meeting of the shareholders: "These steamers will, of their kind, be the biggest thing which has yet been done in the world, and we have, therefore, desired to give the utmost care and consideration to every point before we definitely place the order with any one. It has not been time wasted, and we have had the benefit of the advice of some of the best experts in the country in many matters. As you will very well understand, even those of you who have the least acquaintance with these matters, there is a vast amount of detail which requires to be thought out in connection with these steamers, especially as I can safely say that no shipbuilders were prepared, when we first went to them, to undertake straight away the building of such ships as we required. The best dimensions for the ships, their internal arrangements, the placing of their weights, their draft, their engine power, and many other details, have required the greatest thought and care. I have the utmost confidence in what the result will be, and I am sure that time given now in thinking out these things is of the utmost value in the long run, and that we shall feel that we have left no stone unturned in endeavouring to design two perfect ships, which will, I trust, not only give satisfactory results to our shareholders, but will be such ships as both the company and the country will be proud to own."

"AN ENTIRELY BRITISH COMPANY."

And to preserve the Cunard Company as an entirely British company an alteration has been made by resolution of the shareholders in the articles of association. These now include clauses specifying that it is to be regarded as the cardinal principle of the company that it is to remain under British control, and accordingly that no foreigner shall be qualified to be a director or principal officer of the company, and no share shall be held by or in trust for, or be in any way under the control of any foreigner or foreign corporation, or any corporation under foreign control. The expression "foreigner" is to mean any person who is not a British subject, and "foreign corporation," any corporation not established under and subject to the laws of some part of His Majesty's Dominions, and having its principal place of business in those Dominions. New clauses have been adopted requiring a declaration of nationality in share transfer transactions, and empowering the directors to enter into any agreement with the Government as to carrying mails, building vessels, placing the fleet at the disposal of the Government, whether by sale, hire, or otherwise, with power to issue to any nominee of the Government a share or shares of the company, carrying such voting power as the directors may think fit. To the capital of the company is added a new share of £20, called the "Government share," and only to be issued to a nominee or nominees of the Government, with a controlling vote only on points relating to national policy. These changes are the outcome of the agreement with the Government in connection with the new fast steamers, and constitute a sort of unique alliance between the State and a commercial company.

MARCONI INSTRUMENT ROOM.



FACTS ABOUT HIGH-SPEED TOOL STEELS.

BY

J. M. GLEDHILL.

The following abstracts are from a very complete paper on high-speed steels, read by the author before the Coventry Engineering Society. Specimens of the more important alloys used in the manufacture were exhibited, and the samples of work produced by high-speed steel were remarkable for their excellent finish and accuracy. For the accompanying illustrations we are indebted to Sir W. G. Armstrong, Whitworth, and Co., Ltd.—ED.

THE development of high-speed steel during the last few years has revolutionised alike the theories and treatment of tool steel, as well as its uses in our engineering shops. In proof of this it need only be considered that we have the paradoxical condition that whereas it was formerly necessary above all things in treating self-hardening steel, that every care should be taken not to over-heat it, that is to exceed a temperature of between 1,500 and 1,600° F., otherwise its nature and cutting power would be seriously impaired, now it is one of the essential conditions to heat up the high-speed steel very considerably above these temperatures; in fact to so high a temperature as 2,200 or 2,300 F., that is, a temperature which would practically melt pig iron. This is a truly remarkable paradox, and forms one of the most striking phenomena in the recent history of steel treatment.

Partly as a result of this it is now possible with high-speed steel to turn and machine steel at a rate up to 400 ft. per minute, and also to drill cast-iron at 25 in. per minute! These are indeed remarkable speeds when it is remembered that only a comparatively short time back with the ordinary crucible steels a cutting speed of 30 ft. to 50 ft. per minute was more like the limit.

RISE AND DEVELOPMENT OF HIGH-SPEED STEEL.

It is to Messrs. Taylor and White, of America, that the credit of initiating high-speed cutting is due, and who, some few years back, showed what was then considered to be some remarkable cutting speeds. It will, however, not be denied that the improvement and development beyond their process that has taken place during the past few years is due to our own country, for whereas in the Taylor-White process their steel could not be sent out in bars, but only in the form of finished tools specially treated on the nose only, now high-speed steel, manufactured in this country, is delivered to users in the ordinary way, and further, its forging and treatment is absolutely simple, in fact, simpler, and is accompanied by less risk than in the case of ordinary tool steel. The English manufacturer is even exporting high-speed steel on a large scale to America.

In forging, annealing, and hardening crucible steels it is essential that the most suitable temperatures should be found for all of these processes, and then accurate means be taken to ensure such temperatures being actually obtained as near as practically possible. This can only be effected by the skilful use of pyrometers or other scientific heat-recorders, for to work on the old-fashioned lines of judging by the eye is no criterion of actual temperature, and is no longer advisable. It is now known that every composition of steel has its own definite temperature that is best suited for obtaining from it the most satisfactory results, and the nearer this can be worked to the better, any deviation from the correct temperature, up or down, involving a corresponding difference in the efficiency of the steel.

SOME OF THE MYSTERIES OF STEEL

On the question of heat-treatment of steel, it is indeed remarkable what divergent effects different temperatures of heating produce on its molecular structure. To look at a bar of steel lying on the ground, one can scarcely believe that it contains as much mystery and complexity as human nature itself. For example, a bar, if it be heated to a certain degree of temperature, may be left in such a molecular condition as to be considered useless and thrown aside as such. Heated up a little higher, its structure is completely altered, the bar attains a good condition, and is capable of standing great tenacity and ductility. Again, if we take another bar of steel of certain composition, we may heat it to a certain temperature when its molecular structure will be such that it can be cut and shaped into any desired form; but go a step further, and heat this bar to a still higher temperature, and rapidly cool it, its molecular condition has again changed. The bar has become intensely hard, and is capable of cutting softer steels—it has, in fact, become tool-steel. If the steel is heated to a still higher temperature, it is in ordinary phraseology termed burnt, and if you then rapidly cool it, the steel is still hard, but its structure becomes granular, and therefore very brittle. Its tough nature and cutting powers have become impaired; in fact, its molecular structure is again changed.

It will therefore be seen how important it is in heating steel all respect should be paid to temperature, in order to get out of it all its inherent qualities. One can imagine a bar of steel saying to those about to treat it, "Heat me properly, and I will serve you well; but heat me badly, and I will abandon you."

It has been stated by some that there is not much advantage in its use, but it is easy to prove very greatly to the contrary. There is nothing like facts in proof of statements, and the author does not only give the results of his own firm, but is greatly indebted to many important engineering firms all over the country using "A.W." high-speed steel for much information as to actual daily practice now existing in their workshops.

ECONOMY OF HIGH-SPEED STEEL.

It is also proved beyond doubt that it is distinctly economical to use high cutting speeds, this being clearly shown in the conclusions arrived at by the Manchester Association of Engineers as a result of an exhaustive series of tests and trials with high-speed tool steel. These trials extended over a period of many months and were carefully carried out under the superintendence of Dr. Nicolson, Professor of Engineering at the Manchester School of Technology, together with a specially appointed committee, and the tests were of a very complete and detailed character.

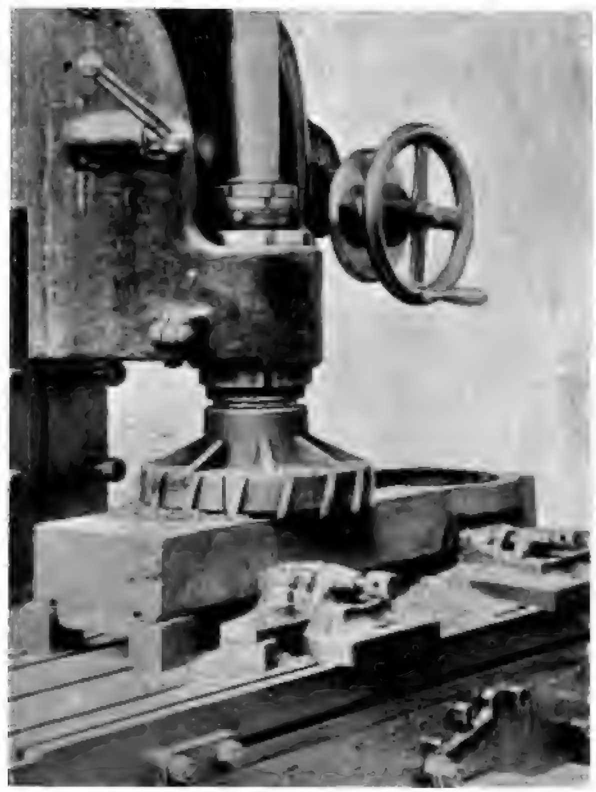
Briefly, some of the results arrived at by this committee were that although more power is naturally required to take off metal at a high speed than at a low speed, the increase of that power is quite out of proportion to the large extra amount of work done by the high-speed cutting. This, one would say is an important point for all users of steel to bear in mind. Of course, it cannot now be denied that machine tools which were fully equal to the cutting power of the old kinds of tool steels are now quite unequal to the capabilities of the high-speed steel—not in driving power alone, but in the absence of rigidity and general strength of working parts for obtaining the utmost work that the high-speed steel is capable of performing. Purchasers of machine tools will, doubtless, in obtaining new designs, note this, so that machines and tool steels which are going to be used in them should be, so to speak, approximately equated. Want of power and strength is undoubtedly being realised, and rapid strides are being made by the leading tool makers to bring their designs into line with the steel.

PRACTICAL TESTS.

A proof of this might here be given: We had at our works an ordinary 12 in. lathe, turning armour-plate bolts of from 4 in. to 5 in. diameter, and we thought we did wonderfully well in turning them at a cutting speed of 80 ft. per minute. We found the tool at the end of the day's work to be practically as good as at the commencement, and this caused an increase of speed to be suggested.

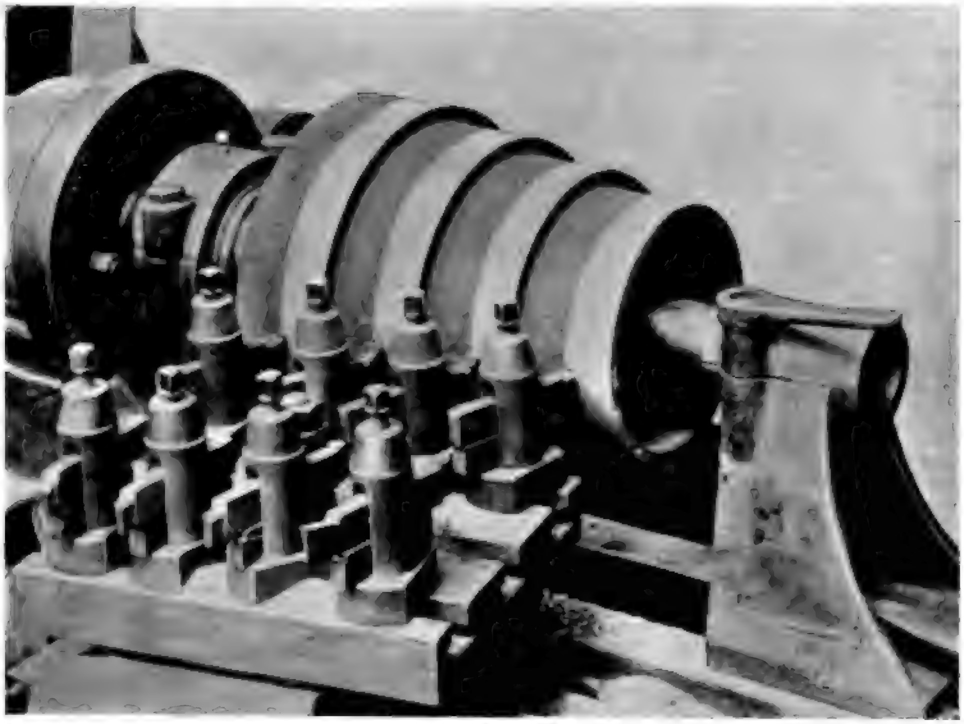
It was found, however, that the lathe had not sufficient power to admit of any increase of speed, and yet it was felt beyond doubt that if we could only get the required power we could run at double the cutting speed.

We therefore designed a special lathe with an increased width of belt from 4 in. to 7½ in. width and



NO. 4. VERTICAL MILLING MACHINE BY MESSRS. ALFRED HERBERT, LTD., COVENTRY,

With face milling cutter 12 in. diameter, with 10 inserted teeth of "A.W." steel. Cutting speed 75 ft. per minute; depth of cut, $\frac{3}{32}$ in.; width, 11 in.; feed, 7·5 in. per minute.



TURNING CONE PULLEYS WITH HIGH SPEED STEEL.
The photo was taken while the lathe was cutting at a speed of 120 ft. per minute.

NEW LATHE FOR TURNING ARMOUR PLATE BOLTS WITH "A.W." STEEL.
One day's work is shown, consisting of 40 bolts. Cutting speed, 152 ft. per minute ; depth of cut, $\frac{3}{4}$ in. ; 32 cuts per inch. Total weight of metal removed, 2,480 lbs., only one tool of $1\frac{1}{4}$-square inch section being used.

an increase of the belt velocity of 400 ft. per minute. The lathe was duly put to work and we immediately began to cut at a speed of 152 ft. per minute, the same depth of cut and feed being maintained as when we were cutting at 80 ft. per minute, whilst the tool, which is 1¼ in. square in section, lasts from seven to eight hours without requiring to be re-ground. So much then for bringing up our machines to the limit of power of the steels.

Another excellent example of high-speed cutting by this steel may be cited: Turning oil-hardened gun-metal having a tensile strength of 40 to 45 tons per square inch, the cutting speed was 50 ft. per minute, eleven cuts per inch, whilst the depth of cuts varies from 3/16 to 11/16, the tool cutting nine hours without interruption.

There is another point raised by some users of high-speed steel, and that is as to its having been found brittle. This, however, is not the case, if the steel is properly hardened, and the hardening confined to the cutting area, and proper support be given to the tools when fixed in the machine.

PRESSURE-RESISTING POWERS.

One example may be given as showing the great pressure-resisting powers of high-speed steel. An "A.W." tool 1¼ in. square section, cutting a steel forging at 25 ft. per minute cutting speed, 7/16 in. depth of cut, with a feed of ⅜ in. per revolution, and removing 14¼ lb. of metal per minute, 855 lb. per hour, withstood easily the very great pressure, which such heavy cutting as this would put upon it, and without showing any signs of weakness. In practice for heavy cutting of this nature a tool of about 2 in. square section would be used; so that it adds further proof when looking at the small section of the tool employed. It may be added that a much higher speed than 25 ft. per minute could have been done if the lathe had had sufficient driving power.

Another example of the resistance of high-speed steel to shock is shown by a tool of 1¼ in. square section used for cutting the top and bottom faces of the webs of a large three-throw crank-shaft. The tool was worked for forty hours without being re-ground, the cutting speed being 40 ft. per minute, depth of cut ⅜ in., and feed thirty-two cuts per inch, and, of course, it will be understood that the tool was not cutting continuously, but the web was coming on the tool intermittently.

HIGH-SPEED STEEL FOR MILLING.

A subject that must be of the greatest importance to all engineers is that of milling, as by the use of this method of working, a much greater output of production can often be obtained. By the use of cutters made of high-speed steel still greater economies are effected, for not only can higher cutting speeds be used than when using ordinary carbon steel cutters, but the cutters made from the former can be run for much longer periods without being ground, and as the grinding of milling and similar cutters is a comparatively costly operation, a further economy is thus effected.

In support of these statements, a few results may be submitted taken from the daily practice at our works. A pair of straddle mills 7 in. diameter, and 1½ in. wide, made of "A.W." steel were used to cut a ⊥ (an inverted Tee section) section from bars of forged steel 7 ft. 3 in. in length, each cutter taking a cut 1½ in. deep, and 5/16 in. wide, at a feed of 1⅛ in. per minute, the cutting feed being 75·5 ft. per minute. After milling eighteen of these bars—a total length of 130·5 lineal feet, and cutting continuously for twenty-three hours and removing 380 lb. each, the cutters were quite uninjured; also, the screw-threads on the armour-plate bolts previously referred to are milled at a cutting speed of 330 ft. per minute, with a feed of 15 in. per minute.

HEATING, HARDENING, AND TEMPERING THE CUTTERS.

With regard to the most suitable processes for the heating, hardening, and tempering of cutters, it is advisable to first fill up the hole and machined parts which it is required to keep to size for fitting on the arbour and keys, with common fireclay. Then place the cutters into a cold muffle furnace; heat up the furnace gradually to a red heat; then transfer

A—45 MINUTES' CUTTING WITH AN "A.W." TOOL.
Cutting speed, 150 ft. per minute. Depth of cut, 3/16 in., with a feed of 16 cuts per inch of traverse.

B—RADIAL ARM DRILLING MACHINE,
With feed as used for High-Speed Twist Drills when drilling cast iron at 25 in. per minute with ¾ in. diameter drills.

the cutters to another furnace already heated to a very bright yellow, about 2,200° F., and allow the cutter to remain in until the teeth or cutting edges are heated to the same temperature as the furnace. Place the cutters under the air-blast until the temperature is lowered just below visible red, that is 1,000° F. Remove cutter from the blast and place into a pan containing tallow, and then heat up the pan to a temperature ranging from 500° to 600° F. Take out and allow to cool gradually, keeping away from cold draughts.

HIGH-SPEED STEEL FOR TWIST DRILLS.

A development of high-speed work, which was not at first looked for, has been in the manufacture and use of twist drills. Many attempts have been made to produce twist drills from ordinary self-hardening steel with usually very indifferent success. Now, however, twist drills made of high-speed steel are a practical success, and are largely in use. To those who are not acquainted with the working of these drills, the results obtained from them will be interesting.

An "A.W." twist drill of 1 in. diameter working on steel plates of 2 in. thickness at 250 revolutions per minute, and 5 in. feed per minute, generally drills 150 holes without re-grinding.

The following is a comparison between a high-speed drill and an ordinary twist drill. Drilling on gun cradles of 5 in. thickness, an ordinary American twist drill did eight holes only and failed, the end being completely burnt up, whilst an "A.W." drill did 124 holes at the same speed and feed without suffering any injury whatever. The drills were 2 in. diameter, running at 80 revolutions per minute, and each hole was drilled in six minutes.

The high-speed drills are equally efficient when used on cast-iron, performing two to three times the work accomplished by ordinary twist drills, as for instance: At the works of Messrs. Alfred Herbert, Ltd., Coventry, an "A.W." twist drill of 1 in. diameter drilled thirty holes through a 3 in. cast-iron block, each hole being drilled at the rate of 7½ in. feed per minute, the drill being uninjured; while a ¾ in. tool drilled cast-iron at 25 in. per minute.

FINISHING QUALITIES OF THE STEEL.

The finishing qualities of high-speed steel have also been a matter of some contention, but there is abundant evidence that it will cut at high speeds and yet give a splendid finish at the same time. In support of this the author may refer to a visit recently paid to the works of the above company (Messrs. Herberts), the finish obtained at high cutting speeds there seen being a revelation. The most excellent finish possible is obtained by them in their very ingeniously designed machinery and when taking one cut only; and their system, and the working of their machinery in conjunction with high-speed steel, is indeed a tribute to the development of thoroughly up-to-date engineering and rapid production of work bearing a high standard of accuracy.

A QUESTION OF NATIONAL IMPORTANCE.

It cannot be denied that the question of high-speed cutting is one of national importance to our country, for if we are to remain successful and retain our position in the engineering world, we must not only possess the best and most modern designs of machine tools, but we must also produce the best qualities of tool steel to serve them to their utmost producing capacities, for it matters not how excellent the one may be if the other is a laggard; the one must be the reciprocal of the other as near as practically possible. Speaking for high-speed steel we must feel that we are only in the early stages of its manufacture and use, and that nothing approaching finality has been arrived at. When the steel maker looks at the innumerable alloys of whose behaviour and proportions when mixed with steel so much has yet to be learned, and also to the infinite number of combinations and percentages of those alloys with steel, and the corresponding varied results obtained, it is easily seen what a large field of research there is yet to traverse.

The Welding of Aluminium.

ALUMINIUM, the most recent of the useful metals, has unquestionably a great future before it. A serious drawback in its application for many purposes, however, has been the difficulty of welding it. As Mr. Sherard Cowper-Coles pointed out in a paper recently contributed to the Faraday Society, soldered aluminium joints have proved unsatisfactory—they will not stand the test of time, as galvanic action takes place between the aluminium and the solder, which of necessity is composed of metals that are electro-negative to aluminium in a voltaic couple. Another difficulty experienced is the complete removal of the film of oxide from the surface of the aluminium to insure the proper adhesion of the solder. The most serious difficulty encountered when welding aluminium is that at a few degrees under its melting point aluminium passes into a mushy or brittle state, and being a very good conductor of heat, the solder rapidly cools, and freezes before flowing sufficiently.

Mr. Cowper-Coles has invented a process for welding aluminium in which no flux or solder is used and which does not necessitate the hammering of the joint when in the semi-fluid state.

The process is especially suitable for wire rods and tubes and other drawn or rolled sections, and consists in placing the parts to be welded after being faced off square, in a machine (fig. 1) fitted with clasping screws, which are capable of moving horizontally on guides; the movement of the clamping screws is controlled by the levers D. The aluminium

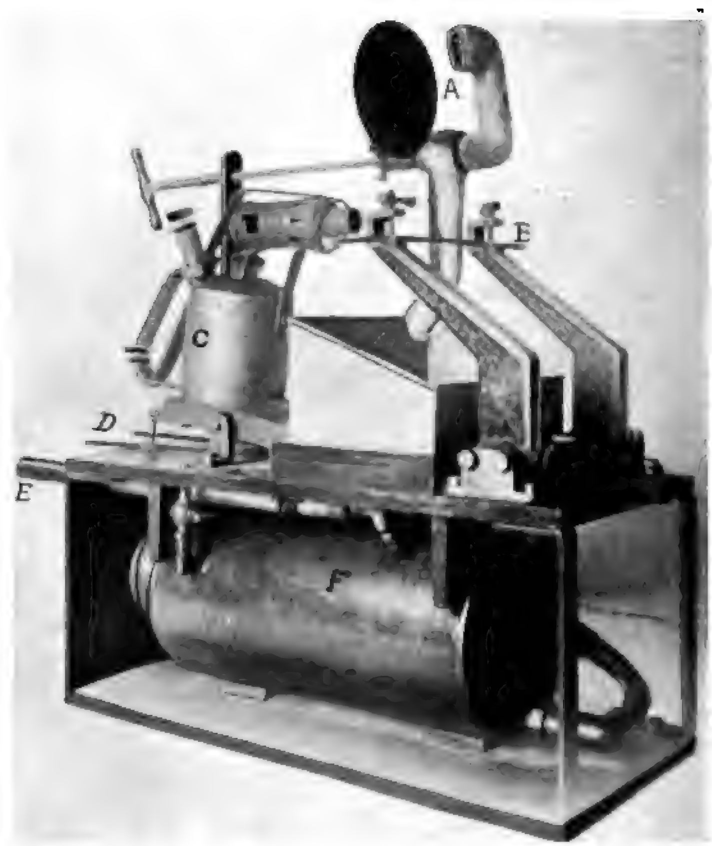


FIG I. COWPER-COLES MACHINE FOR WELDING ALUMINIUM.

A, Screen; B, Aluminium Rods; C, Lamp; D, Levers for applying pressure; E, Pump; F, Water Reservoir.

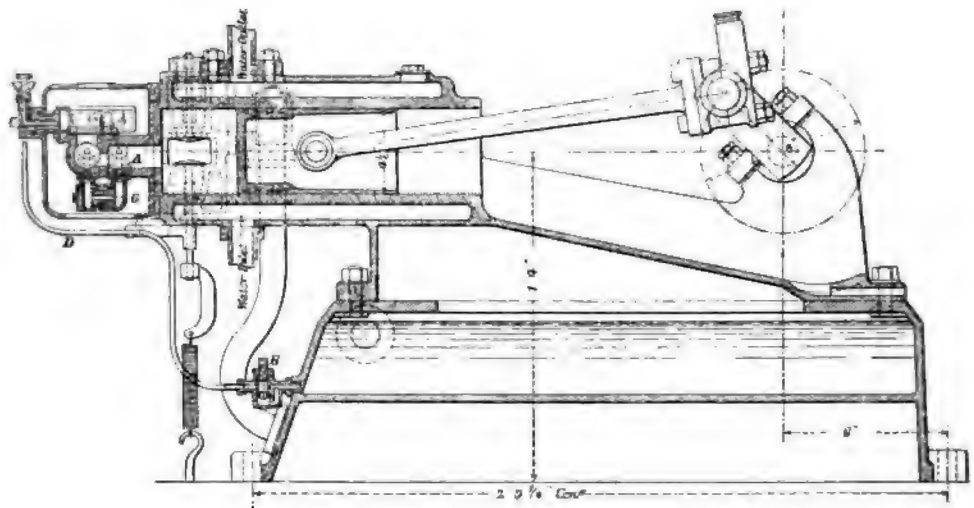


FIG. 2. THE BRITANNIA ENGINE—SECTION.

main mass of the casting A and the vaporiser attain a black heat only, the piece G becomes red-hot. It fails, however, to ignite the mixed gases which pass through it on the out-stroke of the engine, because this mixture is too rich to fire. On the compression stroke, however, the gases forced back through the plug become richer and richer in oxygen until ignition finally takes place. On exhaust none of the waste gases are discharged through the igniter, or superheater. On light loads no gases pass through the igniter or into the vaporiser, unless there is to be an explosion on the succeeding out-stroke. Both plug and vaporiser therefore maintain their temperature, and the engine is not brought to a stop through unintentional missed ignitions.

The funnel shown above the oil-inlet is used in starting the engine. It provides a means by which the oil-pipe D can be filled. This oil is prevented from passing into the tank in the engine-bed by the non-return valve H.

The following parts which exist in other oil engines have been completely done away with: Constant burning lamp, ignition tube, timing valve, overhead gravity feed, oil pump, air pump, oil measure and air blast for starting. The advantages of an engine not requiring a constant burning lamp cannot be overestimated. There are uses to which it can be put where it would be absolutely impossible to use an engine with a lamp. The Britannia engine is made in various sizes by the Britannia Engineering Company, Ltd., of Colchester.

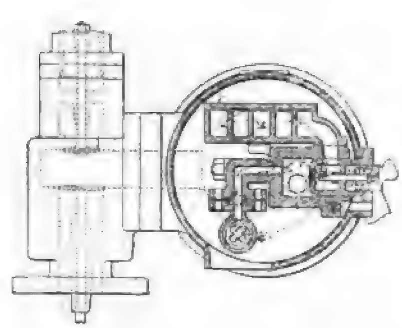


FIG. 3. SHOWING DETAILS OF VAPOUR VALVE.

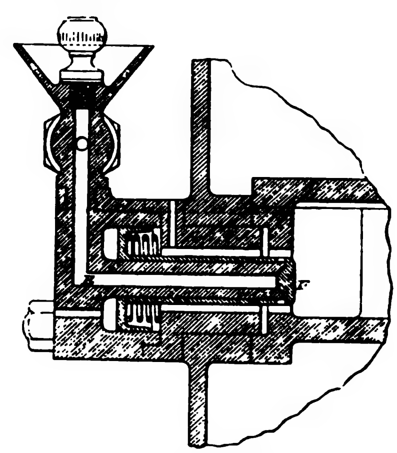


FIG. 4. DETAILS OF OIL FEED.

Radium and its Relation to Matter and Electricity.

By A. F. P.

A Summary of Recent Articles on (1) The Constitution of Matter; (2) Radium; (3) The Rontgen Rays; (4) The Electric Waves used in Wireless Telegraphy.

(1) THE CONSTITUTION of MATTER.

WE shall find it most convenient to begin with a description of the ideas which were held on this subject twenty years ago. In those days, the smallest particle of matter which was supposed to exist at all was called the Atom. Take any substance (a piece of carbon, for instance) and keep on dividing it into smaller and smaller particles. It was imagined that by continuing to divide it one finally came to something which was indivisible—this was called the atom. We get some idea of the size of the atom from the fact that even in a very light substance such as air, one cubic inch contains 100 trillion, (*i.e.*, 100,000,000,000,000,000,000) of these atoms. The atoms in air have plenty of room in which to move about, and dash about freely (in pairs) in every direction with an average velocity of about a third of a mile per second; when they come to any solid substance, such as the wall of a room, their bombardment against it produces a pressure on it of fifteen pounds to the square inch—this we call the pressure of the air.

Now in a solid, such as the wood of a table, the clusters of atoms are closer together, so that there are more of them in a cubic inch. They are so much closer together that they have only a limited range of motion, and more or less stay in the same position. The table, therefore, differs from air in possessing a definite shape.

Nevertheless, the important point is that the little clusters of atoms that make up the substance of the table are separated from one another by quite large spaces, comparatively speaking, so that a table is not really a continuous mass, but more like a sponge.

THE AETHER.

What fills the spaces in this sponge-like mass? We imagine a very thin jelly-like substance, which we call *aether*, to fill these spaces. This aether extends out continuously through space to the farthest star, and by means of it waves of light and heat, and possibly other forms of energy of which we know nothing, travel to us from the sun.

There are then two things in the world: (1) atoms of matter and (2) aether, filling up the spaces between these atoms, and, as we say, soaking through these spaces in matters as water soaks through a sponge.

Ever since the beginning of the last century attempts have been made to reduce all forms of matter to one simple basis; we need only concern ourselves with the latest theory of this kind, developed from the phenomena which take place when an electric discharge is made to pass through rarified gases. The work on this subject begun twenty-five years ago led to the discovery of the Röntgen rays in 1895 and, indirectly, of radium in 1898, and has caused us to rearrange our ideas about matter.

MODERN IDEA OF THE ATOM—THE ELECTRON THEORY.

We must not imagine that the older ideas have disappeared; the grounds on which they were built were too sound for that; the best way to put it is that they have been supplemented and extended. Our idea of the atom has changed; it no longer seems to be the smallest particle of matter that exists, for we have good reason to believe that every atom is made up of a great number of small electrified particles, or electrons, as they are called.

THE ELECTRON.

We shall use the word electron repeatedly, so it is well to remember its meaning. It is not the same as the old atom; a large number of electrons in a cluster form an atom. The name electron is given it because it is a small particle which always carries a charge of electricity.

Though there are over seventy different kinds of atoms that we know of, there is only *one kind of electron in existence*, i.e., *the basis of all matter is the same*. The difference between an atom of gold and an atom of silver is simply that the former atom contains more electrons than the latter. Let us be quite clear: A cluster of a certain number of electrons (some thousands) constitutes the atom of silver; about twice the number of the same kind of electrons in a cluster constitutes the atom of gold.

ITS SIZE.

Now, what is the size of these electrons? We remember how very small the atom was supposed to be; imagine this atom to be 160 ft. long, 80 ft. broad, and 40 ft. high (about the size of the ordinary church), then the electrons would be about one-tenth the size of an ordinary pin-head, *i.e.*, about the size of the full-stop in a newspaper. Imagine a few thousands of these full-stops to be thrown into the church; these would correspond to the electrons in the atom. Now, in spite of their small size, these full-stops will fill the church. They will not fill it in the same sense that excursionists fill a railway carriage, but in the sense in which a few soldiers occupy a country, *i.e.*, by rushing about in every direction, they prevent anything else coming in. The few thousand electrons rush about with such tremendous velocity (about 100,000 miles per second) as to prevent anything else coming into the atom, *i.e.*, the space they occupy is hard and impenetrable. This can be illustrated in the following way: Supposing we take a stick and whirl it round and round with tremendous velocity; the stick, however thin, will effectively occupy the whole of the space in which it is revolving, *i.e.*, nothing else is able to get into that space; so that although there is only a thin stick moving round, that space looks and behaves exactly like a hard, solid, circle of wood. Similarly, in spite of the very small size of the electrons, this cluster of madly-whirling energetic electrons behaves like a comparatively large, solid, impenetrable atom.

But what is the electron? For, by breaking up the atom into these, we have only pushed our enquiry into what matter really is one stage further back, we have not got to the end of it. We only know this about it, that it carries a charge of electricity; it may be that the electron is only a charge of electricity in motion, or it may be only aether in motion. This, however, is more or less speculation.

SUMMARY.

In the light of this theory, let us again consider our apparently solid table; the smallest particles of this, the atoms, are simply clusters of madly-whirling electrified particles, the electrons. The size, the weight, the velocity, and the number of electrons in the atom are being and partially have been determined. The size of the electrons we have just illustrated. The speed is from 60,000 to 100,000 miles per second, beside which a rifle bullet is stationary. The number of electrons in the cluster which makes up a heavy atom (such as the atom of gold) is to be reckoned by hundreds of thousands. A swarm of bees flying together in a cluster will give us a good conception of the atom. There are several kinds of these atoms in the table—Carbon atoms, Hydrogen atoms, Oxygen atoms—differing only in the number of electrons they contain. These three kinds of atoms, when joined together in the proportion of six Carbon atoms to ten Hydrogen atoms to five Oxygen atoms, form a larger compound aggregation, which we call a molecule (*i.e.*, little mass) of wood. These molecules are in motion (somewhat restricted in the case of the table) on their own account.

So the small electron moves about inside the atom; the atom moves about inside the molecule; the molecules, which are separated by fairly large spaces, move about inside the table. And through the spaces between the molecules in the table, between the atoms inside the molecule, between the electrons inside the atom, there soaks the aether, as water soaks through a sponge.

So we have not changed our views; there are still, at the most, only two things; previously we thought of aether and about seventy different kinds of atoms, now we think of aether and one kind of electron.

(2) RADIUM.

Radium is an element whose discovery a short time ago by two French chemists (Madame Curie and her husband) was made possible by the patient work of others during the previous quarter of a century.

Radium is very rare; it costs about £40,000 an ounce. This, however, is only an incidental property, and scarcely worth mentioning from the scientific point of view. (The element Radium has never been obtained alone; what is called Radium popularly is really a salt of Radium, such as Radium Chloride —*i.e.*, Radium combined with Chlorine. This does not matter, as the salt exhibits the peculiar properties we are going to speak of just as well as the pure element Radium would. We shall, therefore, continue to talk of Radium, though its salt is being used.)

The properties of Radium are very extraordinary:—

(1) It is continually giving out heat, without receiving it from any external source, and without falling in temperature.

Also, if a small fragment sealed up in a glass tube is carried for a few hours in a waistcoat-pocket, the skin nearest to the Radium is afterwards found to be blistered.

(2) When Radium is left for some time in a closed space, it is found that another substance, a gas called Helium, is being slowly formed. This last property is of great interest, as it is the first known case of one element changing into another.

(3) Radium has some peculiar electrical properties: it will discharge a gold-leaf electroscope, or any other electrified body (a very delicate test which was used in order to isolate it by Madame Curie); it also emits rays which are either Röntgen Rays or rays very similar to them.

In scientific language Radium is said to discharge three kinds of rays:—

α Rays.—Atoms of matter—possibly of Helium.

β Rays.—Electrons.

γ Rays.—Röntgen Rays—or rays similar to X Rays.

The connection between these three kinds of rays and the above properties will be explained as we proceed.

β RAYS

Let us recall our idea of the atom, a cluster of electrons revolving round one another with a velocity of about

60,000 to 100,000 miles per second. Naturally, with this terrific velocity, it is impossible for all the electrons to remain in the cluster, and some of them fly off into space, *i.e.*, the atom slowly breaks up. Since our attention has been called to this fact, we have discovered that all atoms are breaking up; the point about Radium is that its atoms discharge electrons (*i.e.*, break up), many million times faster than any other element we know.

These electrons carry a negative charge of electricity, and constitute what are called the β Rays; owing to their small size compared with the atom they will pass easily through glass and light solids; they will penetrate a foot of wood or aluminium, and even three-eighths of an inch of a heavy body, such as lead. When Radium is brought near an electrified body these electrons hitting against the body carry away, and in other ways cause a discharge of, its electrification.

α RAYS.

Now the loss of one or two electrons, small though it is, has a very serious effect on the rest of the atom. Suppose that, in a nicely-balanced fly-wheel, revolving at a very great speed, a small portion were to come loose and be hurled away; the balance and cohesion of the rest of the fly-wheel would be seriously disturbed, and it is quite possible that the whole fly-wheel itself would shortly afterwards break up and fly into pieces. This is exactly what happens to the atom; the loss of an electron upsets its nicely-adjusted balance and it proceeds to break up. In the case of Radium the atom breaks up into two unequal parts, a large cluster and a small cluster; the large cluster is unstable, the small cluster is stable and is probably an atom of Helium. These atoms of Helium are (so to speak) slung away with a velocity of about 20,000 miles per second and form what are called the α rays.

(Helium is a very light gas, whose atoms are about four times as heavy as the lightest atom known, that of Hydrogen. The atom of Radium is very heavy, being about 225 times the weight of the atom of Hydrogen, which, in its turn, is about a thousand times as heavy as an electron.)

The larger unstable cluster "emanates" slowly from the Radium (it is called the "Emanation") and appears to go on splitting up again and again, each time discharging more atoms of Helium. In the end stable atoms are formed; it is unlikely that they are all of one kind, but what has been formed besides Helium we do not as yet know. Towards the end, too, there is an increased emission of electrons or β rays.

The α Rays, then, are atoms of matter, very much larger than the electrons; they carry a positive charge of electricity. Owing to their large size they are stopped by glass, wood, a sheet of paper, or even a layer of air an inch or two thick.

The α Rays are by far the most important of the three kinds—they contain more than 99 per cent. of the total energy given off.

PRODUCTION OF HEAT.

Radium, as we saw, is continually breaking up, discharging both electrons and atoms with tremendous velocity. Supposing any of these particles hit a thermometer or the skin? What happens? What happens when a bullet hits a target? So much heat is produced that the lead is melted and spattered about and the target is damaged. So when these particles hit anything which stops their motion, heat is produced, the thermometer rises, the skin is blistered.

The chief way in which Radium obtains heat, however, is through being bombarded by its own rays; the atoms in the interior of the mass discharge α and β Rays; these hit against portions of Radium near the exterior, and are stopped dead; the heat evolved keeps the temperature of the whole mass about 1·5° centigrade above its surroundings.

(The latest idea is that the sun contains Radium, and that the breaking up of the Radium atoms supplies the sun with fresh heat and keeps up its temperature. There is a certain air of probability about this theory; for Radium, when it breaks up, forms Helium, and we know Helium exists in the sun; in fact it was known only as existing in the sun (whence its name) for many years before its discovery on the earth by Ramsay in 1895.)

FORMATION OF HELIUM.

This property is now quite clear—there has been a direct change of one element into another.

Helium is always tested for by the spectroscope. This is, fortunately, an exceedingly delicate test, as a very small volume of the gas is formed from the minute quantities of Radium available for experiments. (The total amount of Radium available in the world at present is about a teaspoonful.)

The Radium is put into a glass tube from which all the air is removed; any gas which comes off is condensed at the lowest temperature known (that of liquid Hydrogen); after a few months the presence of Helium in the condensed gas can be detected by the spectroscope.

Helium is formed by the breaking up of Radium; it is possible that Radium itself is only an intermediate product formed by the breaking up of heavier atoms. We said, a little while back, that all elements seem to be breaking up. If this is so, everything is undergoing the same change as Radium, although more slowly, and is forming more simple elements. In the same way, every element has probably been formed by the breaking up of more complicated elements.

It is possible now to understand a little better the connection between two elements such as gold and silver. The principle of evolution seems to have been in operation, gold and silver being probably both produced by the breaking up of some common ancestral element. There is the same relationship between them in a way as between man and an anthropoid ape, which seem physically both to be derived from some common ancestor. Here, however, there has been an ascent from a more simple type, whereas gold and silver would be a descent from a more complicated

type. Looked at in this way the change of gold into silver is no more possible than that of a monkey into man.

Twenty years ago it was nearly a doctrine of faith that the atom, and therefore the element, was unchangeable. It shows the difference that Radium has made in our ideas when we now have reason to believe that the whole world is very slowly changing into a simple form of matter. Who shall say where this change may stop, short of the aether of space?

(3) RÖNTGEN RAYS.

The last property brings us to a consideration of the Röntgen or X Rays, for the γ Rays emitted by Radium are either X Rays or rays similar to them.

The X Rays were discovered by Professor Röntgen in 1895. He used, in order to produce them, a Crookes tube—*i.e.*, a highly-exhausted vacuum tube through which an electric discharge is taking place. The rays given off from this tube, though producing very little effect on the eye, make a phosphorescent screen luminous, and will act on a photographic plate. They will pass, to a greater or less extent, through articles of wood, clothes, flesh, or metals. Any of these bodies placed between the Crookes tube and the screen, casts a more or less dense shadow on the screen. It is found that the rays pass more easily through light than through dense solids; consequently, in the case of the hand, the bones form a darker shadow on the phosphorescent screen than the flesh, and we get the skeleton-like effect with which most people are by now familiar.

It is found that in a Crookes tube small electrified particles—our electrons, in fact—are being discharged in their usual vigorous manner across the tube from the negative pole. The negative pole is generally made so as to focus the electrons on one particular spot, where a piece of some heavy metal (such as Platinum) is placed in order to stop them dead. This sudden stoppage produces, in addition to heat, the waves in the aether which he called the X (*i.e.*, unknown) Rays.

To return to the illustration of the target. A bullet hitting a target gives out a flash of light—*i.e.*, sends out waves of light through the aether. So these electrons, which are very much like bullets, when suddenly stopped dead, cause waves (not of light, but waves similar to those of light) to pass through the aether. These waves, or X Rays, then, are produced whenever electrons hit against any substance, and their motion is checked.

It is easy now to see why Radium emits rays similar to the X Rays. The particles flying off from atoms in the interior of the substance, hit against atoms on the exterior; their motion is checked, and the γ Rays are produced.

Another explanation is that the γ Rays are produced, not by the stopping of the particles, but at the moment of their sudden discharge when the atom breaks up. In this case the emission of γ Rays must be compared with the light given out by the explosive action in a gun.

The γ Rays have very great penetrating power—even more so than the β rays.

(4) HERTZ WAVES.

Leaving Radium, we might try to answer the question: In what way do the X Rays differ from—

(1) Light Rays.

(2) The Electric Waves used in Wireless Telegraphy (called *Hertz* Waves, after their discoverer) which will pass through solid walls?

We spoke of a thin, jelly-like substance, called the aether, which soaks through all matter as water does through a sponge, and said that this solid table was not really a continuous mass of matter, but consisted of very small particles, with very large spaces in between, these spaces being filled by the aether.

Now, X Rays, Light Waves, Hertz Waves, are all the same in one sense—they are all waves in the aether. They differ from one another only in the same way that the sound wave (an air wave) produced by striking a note at the top of a piano differs from the sound wave from a wire at the bottom of the piano. Imagine our ears to have a much less range than they have, so that we only hear notes in the middle of the piano—*i.e.*, notes within the range of the human voice. We should not hear a note struck at the top of the piano, because it would be too high; we should not hear one at the bottom, because it would be too low.

Now, our eyes have really a rather limited range as far as aether waves are concerned. We cannot see the X Rays; their note—if we can so call it—is too high for our eyes. We cannot see the electric waves used in wireless telegraphy; their note is too low for our eyes. There is no more difference, in this sense, between X Rays, light rays, and the electric waves used in wireless telegraphy than between the notes struck at the top, middle, and bottom of a piano; the latter are all sound waves in air, the former are all electric waves in aether.

Our eyes will only respond to waves within a rather limited range. These waves we call waves of light. We have consequently to invent an "eye" for X Rays, such as the phosphorescent screen (made of a chemical such as barium platino-cyanide), of which mention has been made. Or we can make the X Rays take a shadow photograph. In this case no camera is needed; the photographic plate (protected from light by being enclosed in an envelope) is placed on the table; above the plate the hand is placed; above the hand the Crookes tube. More rays pass through the flesh than through the denser bones; more through the bones than through a metal ring; so that in the photograph the flesh comes out very faint, the bones blacker, and a metal ring quite black.

To recognise the electric waves in wireless telegraphy, a special piece of apparatus is used, called a Coherer; the construction of this does not matter very much just now, as long as we understand that it serves as an "eye" for these Hertz waves, in the same way as the photographic plate and the phosphorescent screen are "eyes" for Röntgen Rays and our own eyes indicate the presence of waves of light.

WHY WAVES OF LIGHT DO NOT PASS THROUGH SOLIDS.

But why do X Rays and the Hertz waves pass through solids, whilst waves of light do not? Light waves will not pass through because the waves are about the same length as the spaces between the atoms in a solid. X Rays will go through because they are so much smaller than these spaces. Hertz waves will go through because they are so much larger than these spaces.

The space between the atoms is, roughly stating, about the hundred-millionth part of an inch; a light wave is about the same distance across, and is many thousand times greater than the distance across an X-Ray wave. Hertz waves may have any size from a few inches to many miles across.

Imagine these waves to be the ordinary waves of the sea; imagine the solid to be a long row of high stakes at regular intervals apart in this sea, broadside to the waves.

Suppose that the stakes (which represent atoms) are about three feet apart, and there are forty or fifty rows of them for the waves to get through.

(*a*) Waves of from two to ten feet across will be broken up and almost entirely stopped, and inside the stakes there will be calm. This corresponds to waves of light breaking on a piece of wood—behind the wood it is dark.

(*b*) Imagine the great breakers of the ocean 80 to 100 feet across to break on the stakes; these waves will pass through almost as if the stakes were not there. Similarly, a wall a foot or two through will have very little effect on the Hertz wave two or three miles across, in fact, less than the thinnest tissue paper will have on the light of the sun.

(*c*) Imagine the spaces between the stakes to be some thousands of feet instead of three feet, our waves of two to ten feet will pass through without any trouble. This corresponds to X Rays passing through the spaces between the atoms. If the barrier of stakes be made more dense, the waves will pass less easily through it; in the same way X Rays pass with more difficulty through heavy dense metals than through light wood.

So solid matter is transparent to the Hertz waves because they are so big; to Röntgen Rays because they are so small.

THE LIGHT OF THE FUTURE.

Waves of light are after all only a particular kind of electric wave which happens to be able to excite the nerves at the back of the eye. Our methods of producing these particular waves at the present day are very crude; we create a tremendous jumble of waves of every size, on the off-chance of there being a few of the kind we want. Now if we want a note such as C natural on the piano, we can press a key and get a fairly pure sound (not quite so, because the octaves are always there); we don't sit on the keyboard or hit it with a sandbag somewhere about that particular spot; in the same way we shall probably be able to invent some electrical device which will serve as an efficient light "piano"; by pressing a key we shall get a nearly pure "note" of light. We shall then have obtained a light like that of the glowworm, without heat, and without undue waste of energy. As Professor Oliver Lodge says: "It is not too much to say that a boy turning a handle could, if his energy were properly directed, produce quite as much real light as would be necessary for use in a small town."

REMAINING PROPERTIES of RADIUM.

One or two facts about Radium still remain to be noted.

(1) Radium is faintly luminous. This appears to be a property not of Radium itself but of its "emanation" (*q.v.*). This property can be transferred to other objects: The hands and clothes of a person handling Radium glow with a phosphorescent light, which lasts for some time after the Radium has been put away.

(2) If Radium, or bodies like it, are placed near a phosphorescent screen, the rays falling on the screen make it glow and give out light. It is just possible that by making use of this property we may obtain an economical source of light in the future.

(3) If a very small particle of Radium be placed in front of a screen containing zinc sulphide, the α Rays (atoms of Helium) produce a very curious effect. As each atom hits the screen, the same effect is produced as when a bullet hits a target, *i.e.*, a flash of light is produced. This bombardment of the atoms can be seen in a darkened room by means of an instrument called a Spinthariscope.

(4) The ore of Radium is called Pitchblende. About 12,000 tons of this would have to be treated to obtain one pound of Radium; consequently, the process of separation is very long and tedious.

(5) Radium is said to be a cure for cancer. This at present seems doubtful.

(6) It is probable that the medicinal properties of certain waters, such as those at Bath, are due to small quantities of Radium existing in them.

SUMMARY.

Radium.

α Rays.	Atoms of Helium—velocity about 20,000 miles per second, easily absorbable, and stopped by even a sheet of paper. Recognised in Spinthariscope. Carry positive charge of electricity. The most important of the three kinds of Rays. Contain 99 per cent. of energy given off.
β Rays.	Electrons (mass $\frac{1}{1000}$ of atom of Hydrogen) velocity about 100,000 miles per second. Will penetrate a foot of wood. Carry negative charge of electricity.
γ Rays.	Probably Röntgen Rays—waves in the ether. Great penetrating power.
The "Emanation."	Luminous. Something like a very heavy gas. "Emanates" from Radium as an intermediate product in the formation of Helium.

Radium is always about 1·5 deg. C. above the temperature of its surroundings—it has marked physiological effects—its rays will discharge electrified bodies and act on a photographic plate.

All of these properties are due to the breaking up of the Radium atom; a specimen of Radium is continually losing weight, but its life is probably over a thousand years.

APPENDIX.

SCALE OF ELECTRIC WAVES IN THE AETHER.

Number of Vibrations per Second:—

Probably Trillions		X-Rays.
2,000 Billions		Actinic Waves (waves used in Photography).
750 Billions to about 400 Billions.	Violet Indigo Blue Green Yellow Orange Red.	The Range of Human Sight. (One octave.)
100 Billions.		Below Red—chiefly Waves of Heat.
230 Millions downwards . .		Electric Waves used in Wireless Telegraphy, *i.e.*, Hertz Waves.

PROFILE OF H.M.S. "TRIUMPH" (LATE LIBERTAD).

NAVAL ARCHITECTS' SPRING MEETING.

AN ACCOUNT OF THE ANNUAL MEETING OF THE INSTITUTION OF NAVAL ARCHITECTS.

THE annual meeting of the Institution of Naval Architects was held in the hall of the Society of Arts (by permission of the Council) on Wednesday, Thursday and Friday, the 23rd, 24th, and 25th of March, and was well attended. The Right Hon. the Earl of Glasgow, G.C.M.G., LL.D., presided.

WEDNESDAY.

Proceedings commenced with the presentation of the annual report of the Council, which was read by the Secretary, Mr. R. W. Dana. The following is an abstract:—

The Council had pleasure in reporting the institution's satisfactory progress during the past year. The increase in the roll of membership* was above the average of recent years, and the list of new candidates for admission was well maintained. The treasurer's report spoke for itself of the satisfactory condition of the institution's finances. The losses by death recorded in the report included the Earl of Ravensworth, second president of the institution, who for thirteen years ruled over its destinies, Sir Frederick Bramwell, K.C.B., F.R.S. (vice-president), and Mr. John Scott, C.B. (vice-president)—an original member of the institution.

It was announced that there will be no regular summer meeting this year, but that an invitation has been received from the Committee of the International Engineering Congress to be held in St. Louis, U.S.A., commencing on October 3rd, inviting members of the institution to take part in the congress.

Amended rules now submitted for the confirmation of members provided more exactly defined qualifications required of candidates for membership and associate membership. A student class will be created enabling young men between the ages of eighteen and twenty-five to join the institution without entrance fee, and at a lower rate of subscription. The Council also recommended that powers be taken in the bye-laws to hold examinations and confer certificates for proficiency in naval architecture and marine engineering. In view of these changes the Council had great pleasure in announcing that Mr. A. F. Yarrow had intimated his readiness to offer a scholarship of £50 a year in Marine Engineering in connection with the institution—(applause)—Mr. Yarrow's offer being conditional upon a second scholarship of the same value from some other quarter, and the Council hoped that another donor might come forward to fulfil this condition.

The question of an experimental tank in connection with the National Physical Laboratory at Bushey had been further considered by the Council, and in order to elicit a definite expression of opinion on the subject from the members generally, Sir William White, K.C.B., LL.D., at the special request of the Council, had kindly consented to read a paper on the subject of experimental tank work at that meeting. (Hear, hear.)

The Council had much pleasure in announcing the award of the annual gold medal and premium for the past year, viz.:—Gold medal, to Mr. W. H. Whiting, for his paper on "The Effect of Modern Accessories on the Size and Cost of Warships." (Applause.) Premium, to Mr. R. Balfour, for his paper on "Marine Installations for the Carriage of Refrigerated Cargoes." (Applause.)

THE AGE LIMIT OF MEMBERS AND ASSOCIATES.

The report and accounts having been adopted and other formal business transacted, the alterations to rules relating to the admission of candidates were formally dealt with. It was mentioned that the limit of age of members would be raised to thirty, and that of associate members from twenty-two to twenty-five.

PRESIDENT'S ADDRESS.

The President proceeded to deliver his address. After a feeling reference to the losses by death mentioned in the report, he briefly reviewed the present position of shipping, which, it was remarked, had not shown much signs of improvement; in fact, during the year under review, statistics point to a period of acute depression. The gross tonnage launched during the year in the United Kingdom (exclusive of warships) was 1,190,618 tons, as compared with 1,427,558 tons for 1902, a reduction of no less than 236,940 tons, or over 16 per cent. On the other hand, the tonnage

* Membership (1903)—Honorary members, 14; members, 1,036; associate members, 66; associates, 511. Total, 1,627.

of warships launched totalled 151,890 tons, as compared with 94,140 tons in the previous year, or an increase of 57,700 tons; so that the total reduction for the year was reduced to 179,190, or under 12 per cent. Moreover, the increase in warship tonnage is due entirely to vessels built in private yards, the total of which is this year almost equal to that of 1901—a quite exceptional year. In Ireland, however, at Messrs. Harland and Wolff's, the tonnage launched during the year had reached the high total of 110,463 tons, or 31,000 tons above the preceding year; while engines aggregating over 100,000 horse-power have been turned out by the same firm. Foreign shipbuilders seem to have fared slightly better, comparatively speaking, than those of the United Kingdom; for, although the returns of most of the principal shipbuilding countries show a reduction on the figures of the previous year, yet this reduction is proportionately less than that for the United Kingdom during the same period. In the field of naval engineering there is little, if anything, to chronicle in regard to new departures during the past year. No doubt our marine engineers have not been lacking in the initiative that has always distinguished them, but such advances as may have been made have been in the improvement of detail. The world is still watching and waiting for the practical demonstration of the use of the steam turbine in larger vessels of the ordinary sea-going class, and ships that are now under construction or about to be tried. These will, doubtless, afford data which will enable engineers and shipowners to form some idea as to whether this new description of prime mover will effect the revolution in marine propulsion foretold by its advocates.

The remaining topics touched upon by the President included the possible utilisation of gas engines on board ship, the use of liquid fuel, the training of engineers, the Yarrow scholarship, and the Navy Estimates. He referred with satisfaction to the provision in these estimates for the thorough renewal of the machinery and equipment of the Royal Dockyards during the next two years, and remarked that the experimental adoption of the premium system in the dockyards would be watched with great interest. If the system was as successful as its advocates predicted, a very great improvement in the dockyard *personnel* would doubtless ensue. (Hear, hear.)

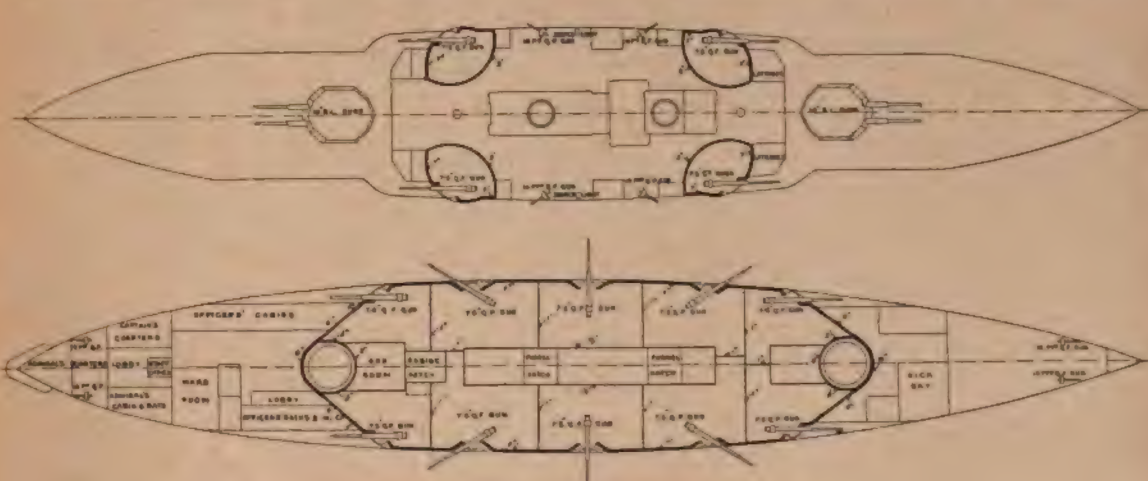
PRESENTATION OF GOLD MEDALS.

The gold medals referred to above were then presented, the President heartily shaking hands with the recipients.

THE "TRIUMPH" AND "SWIFTSURE" AND THEIR CRITICS.

The first paper on the list, by Sir Edward J. Reed, K.C.B., M.P., was largely based upon the criticisms that have been expended upon these vessels, formerly known as the *Libertad* and *Constitucion*, and it may be said to have been dominated by a note of impatience. "It is to be hoped," Sir Edward remarked, "that the future trials and reports upon these ships will be free from the strong adverse bias with which they, since their purchase by the Admiralty, have been treated by the Secretary to the Admiralty and some others."

The paper was largely occupied with a critical comparison between these battleships and H.M.S. *Duncan*, which was recently selected in the House of Commons by the Secretary to the Admiralty for the purpose of comparison. Incidentally, the author said that what the Secretary to the Admiralty could mean by suggesting that, for equal efficiency, the "displacements" must be alike, he did not know; for, if ships with a given amount of fighting power and of speed were to be pronounced inferior because they were of less "displacement," then improvement in design, in so far as economy and efficiency were concerned, was thereby barred. If a ship was of given gun-power and armour, and of given speed (other things being alike), it was absolutely of no advantage to her, but of grave disadvantage, for her to have more displacement than was necessary, for a very large part of the art in the designing of battleships consisted in obtaining the necessary fighting power and speed on the least displacement. From this it also followed that, if one designer could obtain the given power and speed—coupled, of course, with equally efficient armour protection—on much less displacement than another required for the same purposes, it would be obvious to everyone present that the smaller ship was the better ship. The Secretary to the Admiralty seemed to suppose, or to have been induced to suggest, that it was an advantage for the *Duncan* to have 770 tons more weight of hull than



H.M.S. "TRIUMPH." UPPER AND MAIN DECKS.

the *Swiftsure* and *Triumph*, and 530 tons more armour to protect the enlarged hull.

Sir Edward Reed's arguments led up to the claim that, given their size, speed, armour, and gun-power, these vessels have not so far been matched by any other battleships with which he has become acquainted; and "in this remark he might almost include those astounding battleships now building of the *King Edward VII.* class, which, although of nearly 5,000 tons greater displacement, and less speed, are not very much above the *Triumph* and *Swiftsure* in the muzzle energy of the aggregate broadside. Why a secondary battery of only 6-in. guns has been given to these enormous ships far surpassed his powers of conjecture." (Hear, hear.) *

A MARVELLOUS SIMILARITY AND A DISCLAIMER.

A curious point raised was the marvellous similarity between the design of H.M.S. *Cressy* and that of the *Swiftsure*. Sir Edward Reed, however, placed it on record that the design of the *Swiftsure* and *Triumph* was to all intents and purposes settled in Chili without the smallest reference to the *Cressy* or to any other of His Majesty's ships. He went further. He "hoped it was not disturbing to anyone at the Admiralty Office, or to anyone who had been at the Admiralty, to suggest that Admiralty designs had not been considered by him as examples to be imitated. They have always, in his opinion, for many years past been too large for their armaments and their speeds, and it never occurred to him, when arranging the designs of these two ships, to found them upon any Admiralty design whatever, and for that simple reason.

The truth was that he could only account for the large dimensions of many of His Majesty's ships, when taken in relation to their armament and speed, by presuming that their dimensions were fixed in a somewhat arbitrary manner, and so as to be certain that they should be large enough; whereas it was his opinion that the dimensions and power should grow out of, and be the sequel to, the guns to be fought and the speed to be attained. He should have the full concurrence of at least one Admiralty officer of high position in this respect, because the present Director of Naval Construction, Mr. Philip Watts, stood in his estimation as the modern exponent of the system of design which emphasises the gun-power and speed, and brings down to the lowest practical point the weight and power necessary for the purpose in view."

SIR WILLIAM WHITE SPEAKS AS A TAXPAYER.

Sir William White knows as well as anyone the "slings and arrows" that are brought to bear upon Naval constructors by outrageous critics, and while controverting some of Sir Edward Reed's statements, was no doubt able to sympathise with him in this particular. As Sir William reminded us, he can now speak as an ordinary taxpayer, and as he is specially interested, being the designer of the *Duncan* "and a few other vessels"—to use his own unassuming phrase—he availed himself of the opportunity freely. He first took exception to the basis of comparison, pointing out that these two ships had been designed under most favourable circumstances, for they had not formed units in a great fleet, and had been consequently free from special conditions. In these ships, moreover, they had the latest expression of the advances made in armour, armament and machinery, and when a comparison was made between the *Duncan*, designed in 1898, and these ships, designed five years later, that meant a great deal. If he had started again to design the *Duncan* at the present time, he would be able to do more than was possible at the time.

In the course of a friendly fusilade of facts and figures, it was shown that though the *Duncan* is a larger ship than the *Swiftsure* or the *Triumph*, a good deal has been got out of the extra displacement, the *Duncan* carrying 234 tons more equipment, 600 tons additional weight of machinery, and 580 tons additional weight of armour. As to the weight of the hull, Sir William remarked that if Sir Edward Reed could design a lighter hull equally strong, he would like to see the specification. The distribution of armour and guns was also criticised, in detail, and the tabulated muzzle energies for the new ships were questioned, on the ground that the velocities were only obtainable with nitro-cellulose, which was not approved in the Royal Navy.

He gave figures to show that the *Swiftsure* is practically of the same dimensions as the *Cressy* class, of which Messrs. Vickers built two ships; that by omitting wood and copper sheathing over 500 tons were saved in the *Swiftsure*, while the reduction in speed from 21¾ knots to 19½ knots, and in power of engines from 21,000 in the *Cressy* to about 13,000 in the *Swiftsure*, saved over 600 tons. These savings were applied in the *Swiftsure* to increase in armament and armour, but he did not consider that she could do the *Cressy's* work as a cruiser.

The discussion was continued by Admiral FitzGerald, Mr. E. H. D'Eyncourt, Admiral Sir E. Fremantle, the Hon. T. A. Brassey, and Mr. Seaton. Admiral Fremantle mentioned that he had always favoured the small ship, and if the *Triumph* was really equal to the *Duncan*, then a very great stride had been made. The Hon. T. A. Brassey thought the Admiralty had done a very wise thing in purchasing these vessels. They had good speed and good gun power, and in coal capacity were equal to any ship that was now in course of completion, either for our own or foreign navies. Sir Edward Reed received a hearty welcome after his recent illness, and was cordially thanked for his paper.

WANTED—MORE STEAMSHIP SUBSIDIES.

The Right Hon. Lord Brassey, K.C.B., D.C.L., contributed a paper on Merchant Cruisers and Steamship Subsidies, in which he urged a more liberal expenditure on subsidies to fast ocean services, thus providing the fleet, at the lowest cost, with a reserve of ships for scouting duties. It was argued that our shipbuilding should be concentrated more largely on battleships and their indispensable auxiliaries the destroyers. The armed cruisers for the protection of commerce must be regularly built vessels of war. Ships for scouting should be obtained from the Mercantile Marine. Speed and coal endurance are the essential qualities. No vessels of war have as yet been equal to the ocean liners. The German ships have an ocean speed of 23½ knots.

Foreign countries look on their fleets of postal vessels as indispensable auxiliaries to their navies. They are liberal in subsidies. In proportion to the tonnage of their mercantile navies and the requirements of their fleets, they are more liberal than the British Government. The total annual payments

[* This extract has been revised by Sir Edward Reed since the reading of the paper.]

as reported by the Committee on Steamship Subsidies, are as under :—

British mail subsidies	£756,580
Additional payment to Cunard Company	150,000
Admiralty subsidies	77,813
	£984,393
French subsidies (including bounties for shipbuilding and navigation)	£1,787,271
Russian subsidies	364,756
Austrian subsidies	318,983
Japanese subsidies (approximate)	750,000

In conclusion, Lord Brassey remarked: We have already established mail services to the Cape, to the East, and to Australasia. We may improve those services. The ships may be capable of higher speed. They may be fitted with portable armour, and with bulkheads for more minute internal subdivision when employed as scouts. We may establish new lines, such as those so much desired in Canada, to connect the Dominion with Australia and the United Kingdom. And while fostering trade, providing scouts for the fleet, and increasing the means of training for the engine-room complements of the Navy, and more especially for men on whom we may rely as reservists, we may do something effective in a cause which we all have at heart. Swift communications are a bond of Empire.

The discussion by Professor Biles, and Admirals Morant, FitzGerald and Fremantle was not favourable to the arming of merchant ships, though it was pointed out that these vessels might to a limited extent act as scouts. The work contemplated, however, would be far better entrusted to specially built ships.

THE ANNUAL DINNER.

In the evening Lord Glasgow presided at the annual dinner, which was held at the Hotel Cecil. Following the usual loyal toasts, that of the "Naval and Military Forces of the Empire" was given by Lord Brassey, who seized the opportunity of bearing testimony to the success of our Naval administration under Lord Selborne and his colleagues. Discussing Continental naval Powers, he remarked that in Russia and Germany the main efforts were directed to battleships, in France to cruisers. Battleships we must build and cruisers we must build. What should be the type—the type which would hold the field, even for ten years? If he argued for some diminution of dimensions, for not putting too many eggs into one basket, he would be taking ideas which might, perhaps, prevail more widely to-day in view of the latest experience of naval warfare. Cruisers for the protection of commerce must be powerful, fast, and of ample coal endurance. Our latest types were noble specimens of naval architecture. The speaker also paid a tribute to the *personnel* of the Navy, remarking that the service had never been wanting in professional skill, in ardent gallantry, and patriotic devotion. The toast was responded to by Vice-Admiral FitzGerald. The remaining toasts included "The Mercantile Marine," proposed by Admiral Sir J. Dalrymple Hay, "Kindred Institutions," by Sir John Thornycroft, "Our Guests," by Dr. Francis Elgar, and the "Health of the President," by Professor J. H. Biles.

THURSDAY.

THE PROPOSED NATIONAL EXPERIMENTAL TANK.

In the course of a paper on this subject, presented by Sir William White, K.C.B., LL.D., it was shown that the scheme to provide an experimental tank for research work on fluid resistance and ship propulsion at Bushey has been languishing owing to the difficulty of satisfying the requirements of a number of firms who might wish to have models tested at one and the same time. He was in full agreement with the view that it was not wise to contemplate the establishment of a *single* tank in any locality to be available for the testing of ship models in connection with designs.

The inevitable consequence of a fuller recognition of the value of these tanks, as adjuncts to the designing departments of shipyards, must be the establishment by each of the great firms of its own experimental tank.

At the same time he expressed his profound conviction that, if the shipbuilders, marine engineers, and shipowners of this country are well advised, and desire to further to the utmost the maintenance of our supreme position in mercantile ship construction, they will not be slow in providing the funds necessary for the establishment and maintenance, in connection with the National Physical Laboratory, of a tank avowedly devoted to research work on the general principles of fluid resistance, the efficiency of propellers, and other matters greatly influencing economy of propulsion. Generosity in this instance would undoubtedly result in a rich reward. Sir W. White gave an outline of the research work which might advantageously be carried on in an experimental tank such as he recommended. This included investigation of the forms of ships most suitable to fulfil various conditions; frictional resistance; the efficiency and design of screw-propellers; the question of air resistance, which was becoming increasingly important, especially in passenger steamships with enormous superstructures and multiplied shelter decks; the influence of depth of water on the resistance of ships; and investigation of the manœuvring power of ships under the action either of their propellers or their rudders. Experimental tanks also furnished the only satisfactory method of dealing at moderate expense with novel proposals for radical changes in the forms of ships, and of dealing satisfactorily with special cases which arose especially in connection with warship design. He did not put forward this list as exhaustive, but to justify the recommendation which he wished to make, that without further delay steps be taken to secure the establishment in connection with the National Physical Laboratory of a tank which should be of service to the whole shipping community and especially devoted to research.

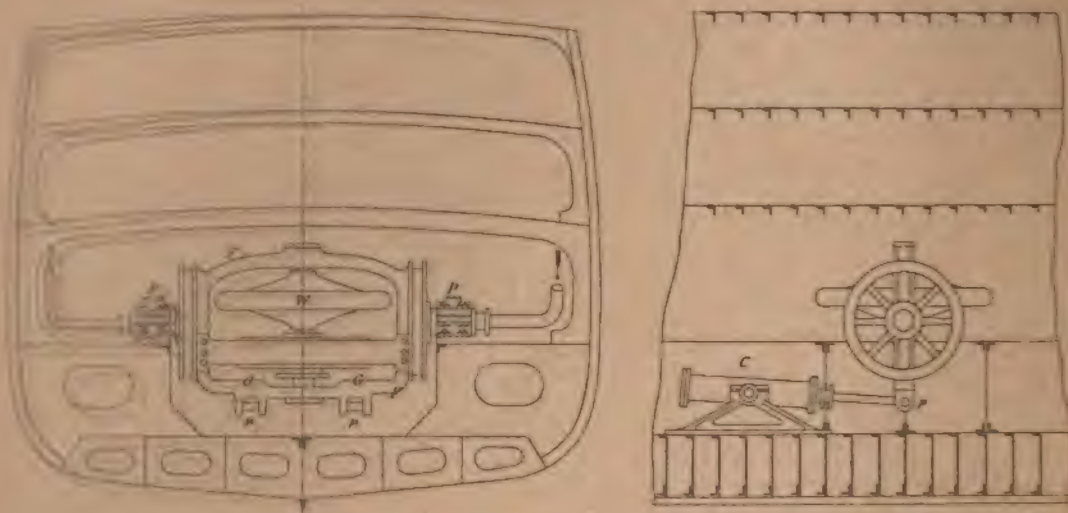
Mr. A. F. Yarrow heartily supported Sir William White's recommendation, and moved that steps be taken to carry it out. This was seconded by Dr. F. Elgar, and carried unanimously. A number of speakers favoured the proposal, including Admiral Melville, U.S.N., Dr. Glazebrook, Herr Carl Busley, Captain Matsuo, Sir Edward Reed and Mr. Philip Watts.

Sir William White thought there would be no trouble in getting the £15,000 required for building the tank, if once the fact were grasped that it would be of real value, while the £1,500 a year estimated to be required for the expenses of working was insignificant in comparison with the saving in cost of coal for the navy and mercantile marine which might be expected as the result of information gained from the experiments.

Sir William White also suggested that shipowners should be appointed on the Committee. This has since been done.

A PRACTICAL ILLUSTRATION SHOWING THE NEED OF AN EXPERIMENTAL TANK.

At the afternoon meeting a valuable paper, entitled "Some Results of Model Experiments," by Mr. R. E.



PROFESSOR SCHLICK'S APPARATUS FOR REDUCING THE ROLLING MOTION OF VESSELS AT SEA.

Froude, occupied the attention of members. The model experiments which form the subject of this paper were resistance experiments, being a series of general experiments on systematic variations in form of hull. They were commenced many years ago, and were continued at intervals as opportunity was afforded by the course of work at the Haslar Experimental Establishment. In the course of discussion Mr. Watts and Sir William White testified to the value of such data to the designer of warships, and Professor Biles remarked that since so many years had been required for the study of practically one form, it illustrated the necessity for such a tank as Sir William White had advocated; otherwise it would be centuries before a complete solution could be at the disposal of ship designers.

A paper on the heeling and rolling of ships of small initial stability, by Professor A. Scribanti, R.Ital.N.R., was taken as read.

THE GYROSCOPE TO CONQUER MAL-DE-MER.

At the evening meeting Professor Otto Schlick described an apparatus which, if successful in application, should earn for him the universal gratitude of sufferers from mal-de-mer. According to Herr Schlick this apparatus makes it possible not only considerably to increase the period of oscillation of a vessel, but at the same time effectively to lessen her angle of heel. This depends in principle on the gyroscopic action of a fly-wheel, which is set up in a particular manner on board a steamer (see illustration) and made to rotate rapidly. It was shown that the energy communicated to the vessel by the action of the waves can be transferred to the fly-wheel, and may, by means of a brake fitted to the latter, be destroyed. The hull of the vessel only transfers to the fly-wheel the energy produced by the waves, and, according to the theory of the top, a very small inclination of the vessel will enable it to do this. In the appliance described, says Herr Schlick, we have an excellent means, if not of *preventing* the motions of a vessel entirely, of at least reducing them to a minimum. In the case of a vessel not fitted with a fly-wheel, it is shown that a wave gives the vessel a certain inclination, which is increased gradually more and more by the following waves. This rapid increase of inclination, after the passing of several waves, is only rendered possible by the circumstance that the damping resistance of the water remains very small (even if bilge keels are fitted) so long as the angle of heel has not become considerable in amount; or, in other words, the work consumed by the damping resistance does not become equal to the energy communicated to the vessel by the succession of waves until a very large angle of heel is reached. The violent rolling motions, then, of a vessel not fitted with a fly-wheel are the accumulated effect of a whole series of waves. When, however, a vessel is fitted with a fly-wheel the conditions become very materially different. In this case the first small inclinations themselves are subject to a powerful damping action, so that an accumulation of roll can never take place. Herein lies the principal work of the apparatus, and at the same time the guarantee for its success. Herr Schlick stated that his principal aim had been to create interest in the scientific aspects of the proposal, while leaving to the future the question of putting it into practice. Some interesting experiments were made in a small tank, and several members joined in discussing the principles of the gyroscope.

OIL AND GAS ENGINES IN VESSELS.

Mr. John E. Thornycroft read a paper on the "Advantages of Gas and Oil Engines for Marine Propulsion," in the course of which he remarked that the advantages which oil and gas engines offered were so great that it was difficult to understand why they had not been more largely used for marine purposes. They necessitated the employment of some complications which steam engines avoided, but the one great advantage of their requiring neither boilers nor condensers would, it was thought, be found to more than compensate for these complications. The different systems, and the way in which they work, were described by the author according to the fuel they employ, under the following headings:—

(1) In which the combustible employed will vaporise at atmospheric temperature.

(2) In which the combustible requires vaporising by heat or by spraying.

(3) Gas engines, using gas from some form of producer using solid fuel.

The first type of engine is necessarily the lightest, as there is no vaporiser or producer, the fuel being vaporised by the simple expedient of sucking the right amount of fuel in with the air to the cylinder. Engines of this class are being made to weigh not more than 10 lb. or 12 lb. per b.h.p. Comparing this figure with that of the modern torpedo-boat's or destroyer's, which is 50 lb. per i.h.p., it is evident that the naval architect has great possibilities with this type of engine. There is every prospect that engines of the second class will be built, including the vaporiser, for not more than 25 lb. per b.h.p. for moderate sizes. The engines of the third-class should not be heavier, but of course there must be added the weight of the producer.

A comparison of the weights and spaces occupied by comparatively low-powered engines of the first class, fitted to launches, in the place of steam engines and boilers of the same power, shows very greatly in their favour; but when petrol is used as fuel, it will be found more expensive than coal to do the same work. On the other hand, as the engines are practically automatic in action, and can be started at once (requiring no preparation like a steam boiler), an engine-driver can usually be dispensed with, and, as the steersman can do all the work of controlling the vessel, it will frequently be found cheaper to run with this class of engine than with steam.

The producer invented by Dr. Mond for using bituminous fuel has not yet been worked out suitably for marine purposes, and as used on land is heavier than boilers of the same power; but it seems probable that, owing to the much greater economy obtained and the rapid development which is going on, it will soon be possible to employ producers of this type.

One of the figures showed the space occupied in a 27-ft. navy cutter by a reversing engine of the second class, replacing the standard pattern steam engine and boiler, which would take just twice the length of the boat. Another showed the relative space occupied by the machinery of a torpedo-boat destroyer fitted with the usual machinery, and an engine of the second class working on the Otto cycle, at the same piston speed as the steam engine.

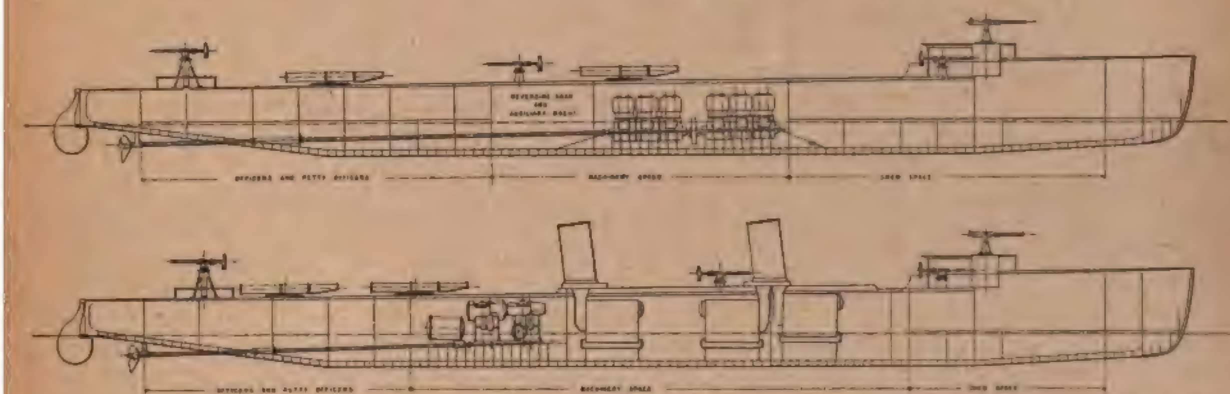
INTERNAL COMBUSTION ENGINES FOR SMALL VESSELS.

Another paper, akin to the last, was read by Mr. Arthur F. Evans, on "The Internal Combustion Engine as a means of Propelling Small Vessels." The author remarked that the application of the internal combustion engine to marine work had placed in the hands of naval architects a power which is destined in the near future to effect a complete revolution in the construction of craft of small tonnage.

The internal combustion engine, or to give it what he considered a more fitting title, "the internally fired hot-air engine," was first applied to marine work by Mr. J. J. R. Hulme, of London, in the year 1885. This was a small inverted cylinder engine, which worked on the Otto cycle and used benzoline —no doubt the ordinary commercial benzoline of about 700° test. It was curious to note, in view of the widespread use of petroleum spirits at the present day, that benzoline was the first fuel to be used in conjunction with marine work. The next oil engine (as he would term it) to be placed on the water was one of Messrs. Priestman's. This was a two-cylinder engine, and was installed in a 28-ft. boat, so that Messrs. Priestman may be regarded as the pioneers of the marine oil engine. The Priestman engine has characteristics which make it very noteworthy, and, considering that their boat was launched in the year 1888, the fact that it was fitted with high tension ignition (in principle precisely as now used) showed how very difficult it was to find anything in the way of mechanical details that was absolutely new.

It was also interesting to note that the first reversing gear tried was a differential gear with a brake, and that this system is not only in general use at the present moment, but that it is, moreover, invented regularly every month by some ingenious and sanguine person. Subsequently, this gear was discarded for the reversing propeller, and he believed that Messrs. Priestman were the first to put a reversing propeller on the market.

A number of other types were described, the author remarking that what is required is an engine that can be started in the morning and shut down at night, and treated in the same manner as the printing office boy treats the shop gas engine. What should be aimed at by designers of marine oil engines for commercial purposes is extreme simplicity, and this question of



DIAGRAMS SHOWING RELATIVE SPACE OCCUPIED BY STEAM AND INTERNAL COMBUSTION ENGINES OF 6,000 I.H.P. FOR A DESTROYER.

simplicity and reliability has, in commercial practice, to stand before fuel efficiency. Perhaps the best instance of this is the Thornley-Savory oil engine.

The paper was illustrated by lantern slides, some very interesting pictures of various motor launches, including one of the earliest and largest motor yachts, a motor fishing boat, a 22-ft. pinnace, the Mayflower and the Alix. It was remarked that last year (1903) would ever be memorable as being the year that initiated the speed contests in marine automobiling, as it is beginning to be called. It saw the production of an excellent boat by Messrs. Thornycroft, another built by the Saunders Company, and engined with an M.M.C. type motor, and the author's own firm's representative, the Napier. In each of these boats a big stride was made both in speed and easy running, as also in price. Up to then £300 was the top price for a motor boat. Twice this amount would not have bought the cheapest of those just mentioned, and the year's racing showed the enormous possibilities there are for boats of this kind. Indeed, everyone who made a journey in one of these boats foretold for their type a great future.

It required no great stretch of the imagination to foresee the possibilities of such machinery for high speed craft designed for even more serious work than motor launch racing. Let the possibilities be considered of a battleship carrying on deck, say, four boats having a speed of 30 knots, and carrying a 14-in. torpedo tube. They would not weigh five tons each, and should be about 60 ft. long, and might be handled by a crew of four.

This year would show a great advance in the direction of highly developed launches, and he hoped by the end of the season that they would be in possession of data that would be extremely valuable. Of course they had to thank the motor-car builders for these developments, but they must remember that what acted quite satisfactorily in a motor-car might not be all that could be desired in a launch.

With the development in the horse-power available per unit of weight came a parallel development in the lines of the boat, and next year, no doubt, the question of lines for high-speed motor launches would be freely debated.

FRIDAY.

THE RATEAU STEAM TURBINE.

Professor A. Rateau, of Paris, contributed a paper on "Steam Turbine Propulsion for Marine Purposes." There was no need, he said, in a country which had given birth to the Parsons' Turbine, to insist upon the interest attached to the application of the steam turbine to the propulsion of ships.

The three principal difficulties encountered were shown to be:—(1) Design and arrangement of propellers for a high speed of rotation; (2) efficiency of turbines at low speeds; (3) reversing and manœuvring powers. These obstacles, in the author's opinion, could only be satisfactorily overcome by a joint use of reciprocating engines and steam turbines.

COMBINED USE OF TURBINES AND RECIPROCATING ENGINES.

The best solution appeared to be the simultaneous employment of a reciprocating engine and turbines attached to independent shafts, in order that the reciprocating engine might be used at any speed. Each kind of engine was thus adapted to the work which suited it best. The reciprocating engine did for slow speeds, while the turbines came into play progressively as the higher speeds up to the maximum were required. They could, moreover, be equally well arranged for going astern, and the combination of the two then made manœuvring almost as easy as with ordinary twin screws. An effective horse-power astern of 75 per cent., or more, of that when going ahead could thus be obtained.

The author's design of turbine consists of a series of flat moving rings, varying in number according to the requirements, and fitted on a single shaft. These rings are placed between circular discs whose rims fit into grooves on the inside of the casing. The shaft traverses these diaphragms through bushes, which allow but little play. Elsewhere, the clearance between the moving and the fixed parts generally exceeds 3 millimetres, and can even be as much as 5 or 6 millimetres without causing trouble. With this arrangement, and by using the work by "impulse" instead of work by "reaction," it has been sought to obtain an engine using as little steam as possible, simple in construction, needing but little care in working, and capable of running for a long time with but little wear and tear, which, although inevitable, can yet be reduced to a very small amount. The loss of steam is entirely confined to the clearance allowed around the shaft. Moreover, the live rings are so constructed as to be very light, and this is of advantage in reducing the gyroscopic effect which comes into play when the vessel pitches. A longitudinal section of the Rateau turbine was shown. It was taken from the one installed on Messrs. Yarrow's boat.

The paper included some valuable details of the application of these turbines to the French torpedo boat, No. 243, and a boat built by Messrs. Yarrow and Co., in which the author's system of turbines was installed. It was mentioned that there are at the present time, either in use or in process of construction, over 50 turbines of the Rateau design, with an aggregate of 25,000 h.p., of which 6,200 h.p. are used for ship propulsion, 950 h.p. for turbine pumps, and 760 h.p. for turbine fans.

The author stated, in conclusion, that steam turbines can be made practically equal to reciprocating engines for propelling ships at high speeds, but in order to obtain their full effect, they must be mounted upon shafts very slightly inclined, and, if possible, with only one propeller on each shaft. The necessity for having horizontal shafts leads to a more sudden rise in the hull aft than is usual when reciprocating engines are installed. Hence, hulls constructed for reciprocating engines are not generally suitable for steam turbines. It must not be concluded from the fact that, *ceteris paribus*, a higher speed is not obtained by merely substituting turbines for reciprocating engines, that the former are therefore inferior to the latter. A new form of propelling engine obviously calls for new lines of hull. At reduced speeds, the turbines are not economical, and they are inconvenient for going astern and for manœuvring, but this drawback can quite well be remedied by combining turbines with a reciprocating engine, working a special shaft and mechanically independent of the turbines. Another arrangement, different from that in the Yarrow boat, whereby the reciprocating engine would supply about 40 per cent. of the total power, would give an increase of 15 to 20 per cent. of the power obtained with a reciprocating engine alone, besides having the general advantages characteristic of turbines.

Sir William White said the paper was remarkable for the frank way in which M. Rateau, though the inventor of a new form of rotary engine, had set out both disadvantages and the advantages. It formed a sub-

stantial addition to our knowledge, and they must acknowledge the generosity of Mr. Yarrow in allowing the results to be published so soon after they had been obtained. He thought there was no need to accept 20 knots as the lowest speed for which turbines were suitable; they could, he thought, be employed for much lower ones. It was an interesting fact that this paper should have been read on the day on which it was announced that the Cunard Company had decided to adopt turbines for their swiftest and largest steamers.

Mr. A. A. Campbell Swinton said that it might be inferred from a statement in the paper that M. Rateau was the first to put the reversing turbine inside the casing of the main turbine, but the first turbine made for purposes of marine propulsion by Mr. Parsons had this arrangement.

Papers, subsequently read by Mr. J. Bruhn, D.Sc., and Mr. A. W. Johns respectively, dealt with "Some points in connection with the Transverse Strength of Ships" and "The Normal Pressures on Thin Moving Plates."

ANTI-FOULING COMPOSITIONS.

Anti-fouling compositions and the protection of the internal parts of vessels from rust were chiefly considered in Mr. A. C. A. Holzapfel's paper. The former were dealt with in two classes: (1) Varnish or enamel compositions; (2) grease compositions.

The author was of opinion that the time had come when manufacturers and consumers should combine to standardise these compositions with a view to ensuring a uniform and reliable article. He had thoroughly satisfied himself that the principal cause of the efficacy of compositions was due to the fact that the mercurial and copper compounds they contained formed, by contact with sea water, a very thin layer or film of chloride solution of the respective metals, and that these chloride solutions were destructive to the organisms which tried to attach themselves to a ship's bottom. These organisms consisted chiefly of spores, larvæ, etc. The chloride solutions of copper and mercury had the effect of coagulating albumen, and it was probably this which caused the destruction of the organisms at the moment they tried to attach themselves to the bottom of a vessel coated with an effective composition.

Comparing the two classes of composition and taking everything into consideration on the score of economy and speed, the author considered that varnish paint would, in the long run, prove to have the advantage. He remarked that bronze propellers should invariably be painted with anti-fouling composition.

FIRE PREVENTION ON BOARD SHIP.

The concluding paper by Mr. Edwin O. Sachs, dealt with the important question of "Fire Prevention on Board Ship." Ships used exclusively or mainly for passenger trade, ships that solely or mainly carry cargo, and ships that carry both passengers and cargo, appeared to the author, to be the three great divisions of commercial shipping, as seen from the fire point of view.

Regarding constructional safeguards, the author considered the primary safeguard in design to be the one which was now being generally adopted on land, namely, that of dividing the ship into a maximum number of fire-resisting compartments. The primary safeguard against spread of fire in all ships of all classes would be their division into the largest number of small fire risks practicable with the work of the ship, and this number could and should far exceed the number of divisions made in order to obtain water-tight compartments.

Turning to the safeguards in the application of materials in the construction of vessels, he considered the reduction of combustible material to a practical minimum to be an essential. For the passenger ship this should be compulsory, and only wood of the non-inflammable description should be used. The "non-inflammability" of wood was a problem which the author considered had been solved commercially.

Regarding safeguards and equipment, the two forms of equipment in respect to which a great deal more attention should be paid were: (1) the protection of the hot steam piping, and (2) careful electric wiring. He advocated that the steam pipe should have additional protective covering beyond its ordinary isolation covering, in the form of a wire guard in all exposed places, so that anything lying right up against it did not touch the pipe or pipe coating, *i.e.*, that there should be an air space intervening.

In all classes of ships, he considered that the safeguard of a fire patrol—as practised on land in the Liverpool warehouses, with regular inspection—should be practised more particularly in the holds and out-of-the-way corners of the ship. It was pointed out that a ship's fire on the sea is not a rarety. In 1903, according to Mr. Harold Sumner, of the Liverpool Underwriters, there were over 300 fires on record for the past twelve months, in ships of over 500 tons register. Of these, 108 were of a serious character.

SHIPBUILDING NEWS.

First Quarter's Shipbuilding.

In last month's notes we referred briefly to the output of the first shipbuilding quarter of the year. Since then the returns from the various districts show that the production of the whole kingdom in the three months, from January to March, 1904, was 300,800 tons, of which 168,900 tons were in England, 102,400 tons in Scotland and 29,500 tons in Ireland. This compares not unfavourably with last year from the shipbuilders' point of view, and the second quarter has opened with a considerable improvement in the industry. Since our last comments a large number of contracts have been booked, and the prospects of the shipbuilder have changed for the better. In Scotland, for instance, it is computed that in March the new contracts booked were for about 50,000 tons, and that during the quarter some 30,000 tons more were booked than were launched. It is true that the work is very unevenly distributed, and that a considerable number of the shipyards entered the second quarter with little or nothing on hand. Still, the district, as a whole, is benefited, and the number of unemployed shipyard workers is reduced. In the North of England the contracting has been still more extensive, and yards which were almost, if not entirely, idle in the closing part of last year are now actively employed.

Shipbuilding Prospects.

This is so far good, but the prospect for shipowners has not improved. During the three months, January to March, some 200 to 250 merchant steamers have been ordered from British builders, representing a carrying capacity of say, a million and a-quarter tons. The trouble in the immediate future will be how to find employment for them. The world's shipping has not been reduced by losses or withdrawals in any way commensurate with the additions now being made to it, while the world's commerce has declined and is declining, as it always does in the periods of depression which follow a boom. As has been already said here, the war in the East has caused some gaps in the streams of ocean carriers; but it has also suspended altogether a good deal of ocean traffic with Japanese and Asiatic-Russian ports. The restriction of trade is greater than the withdrawal of Russian and Japanese shipping. No doubt there is a good deal of tonnage being employed both by Russia and Japan for the conveyance of coal to the Far East at payable freights. In some cases there may be long detentions, but in most cases the difficulty with these vessels will be to get homeward cargoes. But against these diversions of tonnage from normal avenues of employment, we have now to look forward to the new tonnage—very largely of the "tramp" order—that will be put into the water during the remainder of the year. Meanwhile, there is no probability of further reduction in the cost of new ships. Steel plates are £5 15s., less five per cent. in Scotland, and £5 12s. 6d., less two and a-half per cent. in the North of England, and with the growing understanding among steel manufacturers are more likely to be dearer than cheaper—unless American or German stuff comes in. And wages can hardly be lowered when the order books are full.

Lloyd's Returns.

The quarterly shipbuilding returns of Lloyd's Register differ as usual from the records collected from the shipbuilders. As regards the work "under construction" they show that the new quarter began with merchant shipping on hand to the extent of 398 vessels and 988,664 gross tons as compared with 425 vessels, and 974,686 gross tons at the corresponding date in 1903. The total is about 90,000 tons more than at the beginning of January. Lloyd's figures, however, do not include vessels booked but on which work had not actually begun at the end of March. The warships under construction in addition are 74 vessels of 377,115 tons displacement.

The Cunard Commission.

The Commission of Inquiry appointed by the Cunard Company have decided that the turbine should be adopted, and that four shafts and four sets of turbines should be preferred to three. The Commission give many data as to the results of the various experiments made which led to their conclusions. The advantages and disadvantages of the turbine system are discussed in their report, but little saving of weight or area is claimed. The machinery of the two new ships to maintain under all weather conditions a mean of 65,000 i.h.p., will, it is estimated, be only 300 tons lighter than with reciprocating engines; but the Commission advise the Company not to rely on this saving to the extent of adding such 300 tons to cargo or other accommodation, but to hold it in reserve in design for machinery. One important disadvantage dwelt upon is the lack of economy at low speeds; but as the new Cunarders will always run at a uniform speed of 24½ knots, this should be considered a minimum in proportioning the turbines, so that at that speed the greatest power will be secured, and then the coal and steam consumption should be superior to reciprocating engines. In the trials of the English Channel turbine-propelled vessels at full speed these showed an economy of two per cent. over reciprocating engines. The Commission say that this result cannot be accepted as final, because there are several factors influencing efficiency which cannot be eliminated, such as the form of the screw propellers, the form of the stern of the ship and the distance of the propellers from the hull, etc. Economy, however, will result from the use of the turbine by the reduction of the staff in the engine-room, and by the absence of lubricating oil in the exhaust steam.

Shafts and Propellers.

The Commission recommend four shafts not only because four screws will give a higher efficiency, but because it is imprudent to divide the power through a fewer number of shafts. The Commission considered the power necessary to give the sea-speed of 24½ knots with various forms of hull, and although 24½ knots can be realised at sea under normal weather conditions, it is necessary to have a considerable margin of power to ensure that this rate will be maintained under adverse conditions. For this reason 25 knots will be attained on an extended trial trip. Consequently, with three shafts, the power transmitted through each would require to have been about 25,000 i.h.p., whereas, with four shafts it will not much exceed 18,000 i.h.p. There is also to be considered the question of the size of the turbine and the advantage of limiting the number of revolutions per minute of the screw propellers. Large diameter improves the sea-manœuvring quality, and the Committee started with the proposition that the revolutions should be limited to 140 per minute. This is considerably more than with reciprocating engines, but it compares with 300 to 500 revolutions at which smaller turbine-driven vessels are now run. The design of turbine will differ slightly from that in other ships; they will require to be of greater diameter to give the power, and the peripheral speed will consequently be very high, but no greater than with existing turbines.

Cunard Turbine Engines.

It is proposed that there shall be one go-ahead turbine on each of the four shafts, which will be equidistant from each other. The high pressure turbines will be mounted on two outside shafts, which will have the propellers at a considerable distance from the stern of the ship, and thus there will be the minimum of disturbance to the flow of water to the two inside propellers, which will be placed right aft in the usual way. On each of the two inside shafts there will be two turbines. On each there will be two low-pressure turbines for driving the ship ahead. The other two will be for astern motion. The power for ahead motion is to be in two steam units, each with one high and one low-pressure turbine, giving the best expansion of steam; but should there be any breakdown of one set the three remaining shafts may be run, and thus only one-fourth of the power will be unavailable. One advantage of the four screws and of the two central shafts being fitted with astern driving turbines is that the power for driving astern will be equal to one-half the forward motion power distributed through two shafts.

Experimental Tanks.

The Institution of Naval Architects are taking steps to follow up practically the appeal which Sir William White made at the recent Congress to shipowners and shipbuilders on the subject of experimental tanks.* About three years ago at Glasgow, Mr. Yarrow proposed that an experimental tank should be established under the auspices of the Institution of Naval Architects. A committee was appointed to give effect to this proposal, and in March, 1902, a report was submitted to the Council, and the latter authorised the committee to take the steps necessary to raise the sum of £15,000, which, it was estimated, would suffice to build and equip a suitable experimental establishment in connection with the National Physical Laboratory in Bushy Park, where a suitable site could be found. There was, however, in some quarters a conviction that it was preferable to have experimental tanks for testing ship models closer to the great shipbuilding centres, and there was also a fear that in any establishment for testing ship models, representing competing designs or new ideas, there might be a serious chance of leakage or improper use of information. Sir William White did not concur in this view, but he does not think it wise to establish a single tank in any locality. He rather advocates the establishment by each of the large builders of experimental tanks of their own, such as that which Messrs. Denny have for twenty years had at Dumbarton, and as John Brown and Co., Ltd., have now at Clydebank. But what Sir William White advises, and a committee of the Institution of Naval Architects are about to endeavour to carry out, is the establishment of a tank in connection with the National Physical Laboratory for purely research work.

Sailing Ships.

In an interesting address to the Royal Philosophical Society of Glasgow at the beginning of April, Mr. Robert Caird, LL.D. (of the great shipbuilding firm) dwelt on the developments in the means of communication by sea during the nineteenth century. In the course of his remarks he said that the opening of the Suez Canal, among other things, promoted the gradual but unrelenting supersession of sailing ships by steam even on the longest routes, due in great measure to the continuous improvements in marine engineering, tending to increased economy of fuel, to the multiplication of coaling stations and to cheap conveyance of coal to distant points. The statistics of last year show that while 622 merchant steamers of over 2,200 tons average were built in this country, only seventy-two sailing ships of 700 tons average were added to the register. Only one-twenty-eighth of the new tonnage was sailing. But while what Mr. Caird says is quite true we do not believe that the life of the sailing ship is done, or ever will be done. Nor do the sailing ship-owners of Britain, Germany and France, who have formed an International Union for the preservation of each other from each other's attacks on the freight market.

* See page 425.—ED.

Shipping in 1903.

In the course of a restrospect of shipping covering 1903, the editor of the "Shipping World Year-Book" writes: The depression to which we referred when reviewing the position a year ago has pressed still harder upon shipbuilding and shipping during the year 1903. Although the volume of oversea trade was the greatest in the history of commerce, freights have never been so low as during the last twelve months, and this remark applies practically to all shipping trades, in home and foreign seas and countries, with exceptions in the passenger and emigrant business. It goes without saying that this state of things has deterred many shipowners from ordering new tonnage. The best-informed have bided, and are still biding, their time, until the bottom price is touched. Moreover, prices of shipbuilding materials have been well maintained throughout the year; nor have the wages and earnings of artisans and labourers been much reduced; while British yards on the whole have been employed beyond expectation, beyond parallel or comparison (war vessels excluded) with the yards of any other country, and have turned out tonnage at lower prices than have ever before been booked for a similar class of ships. The world's output of war and merchant tonnage during 1903 aggregated 2,730,205 tons, and the contribution of British yards to the whole is 1,424,888 tons. The figures for 1902 gave a total output by the yards of the world of 2,733,024 tons; the contribution of the yards of the United Kingdom, 1,654,644 tons, leaving 1,078,380 tons as the output of the other shipbuilding countries of the world.

It is true that British yards show a decline in output equal to 13·3 per cent., while foreign and colonial yards have an increase of 20 per cent.; the world's production of shipping showing the small falling off of 0·09 per cent. But it must be explained that the more favourable position of foreign yards is accounted for by their largely increased output of fighting tonnage, and the falling off in the Royal Dockyards figures from 51,560 tons in 1902 to 28,290 tons in 1903.

Notable Launches.

Since the last instalment of these notes appeared, Messrs. Harland and Wolff, Ltd., launched the large twin-screw steamer *Dunluce Castle* from the south end of the Queen's Island. The new liner is 475 ft. long by 56 ft. 6 in. beam, and about 8,380 tons gross. She is destined for the intermediate service of the Union-Castle Mail Steamship Company, Ltd. She will have large cargo-carrying and refrigerating capacity. Messrs. Hawthorn, Leslie and Co., Hebburn-on-Tyne, have launched the first turbine passenger steamer for service on the Canadian lakes. The vessel has been built to the order of the Turbine Steamship Company, Ltd., of Hamilton, Ontario, and has been specially designed for the new service between Hamilton and Toronto.

OPENINGS FOR TRADE ABROAD.

Belgium.

Tenders are invited for the construction of a new dry dock, etc., at Ostend. The estimated cost is £120,000: a deposit of £12,000 is required to qualify any tender, which will be received up to the 24th July at 1, Square Stephanie, Brussels.

Spain.

The Santander and Bilbao Railway Company have been authorised to establish a double line between Bilbao and Las Arenas. A Royal Order has authorised the Government to grant a concession, without subvention, for a metre gauge steam railway from Colmenar de Oreja, through sundry towns to Alcazar de San Juan.

Tenders are in demand for the supply of a rotary dredging machine, three lighters, and a floating pump, for use in the Huelva port works. Tenders will be received up to the 8th June, a deposit of 5 per cent. is required to qualify tenders. Persons tendering must state whether the material they propose to supply is new or secondhand. Tenders will be received up to May 9th next, at the office of the Director-General of Public Works in Madrid, for the execution of the work of prolonging certain moles and for other harbour works at Tarragona, at the upset price of 2,339,000 pesetas (or about £66,800). A deposit of about £3,370 is required to qualify tenders.

Nicaragua.

The Government of Nicaragua has a corps of civil engineers surveying the line for a railway from San Miguelito, on the south-eastern shore of Lake Nicaragua, to Monkey Point, on the Caribbean Sea. This line was surveyed for an English syndicate, whose surveyors reported the route as favourable to railway construction, especially the eastern half. The route is projected through a region without population and the through traffic will not pay even a low rate of interest on the cost. It is stated, however, that the President of the Republic will build this railway if possible. With capital to keep the work going the railway can be completed in about two years from its actual commencement.

Portugal.

The plan and estimate, amounting to about £26,183, for the construction of the fourth section of the Southern Railway, between Tavira and Cacella, 12,000 metres, have been approved and working operations sanctioned.

Italy.

The Italian Navy Department has given notice that in future foreign firms will be allowed to compete in all contracts for armour plates and naval supplies, as the Tariff affords the home industry the necessary protection.

Cape Colony.

Bills will be introduced into the Cape Parliament during the ensuing session authorising the construction and working of railways from Isinuku to Umtata, and St. John's to Kokstad. The Council of the Municipality of Kalk Bay will introduce a Bill authorising the Council to supply electricity for lighting, heating, and power purposes for general, industrial, and domestic purposes.

Natal.

A correspondent of the Board of Trade writes:—"It has been known for many years that deposits of iron of excellent quality exist in the northern districts of the Colony, and there is reason to believe that a judicious investment of capital would result in the development of a very important industry there." This would in time necessitate a large quantity of mining gear, tools, etc., for the development of such an extensive property.

Argentina.

The Government has been authorised to construct, directly or by means of private enterprise, in accordance with the existing laws, a large number of bridges and roads throughout the Republic. Among the former may be named the bridge crossing the Riachuelo de Barracas in continuation of the Avenida in Buenos Ayres, at a cost of $300,000 (national currency); a bridge over the River Colorado in el Paso Morales, $100,000; a light cart road bridge over the River Corrientes between Santillan passage and the crossings of the river by the railway line, $540,000; construction of a cart road bridge over the River Mendoza at Palmira, $250,000. Tenders are invited for the supply of twelve locomotives, 100 closed wagons, and 100 open trucks for the Central Northern Railway of Argentina, in accordance with plans and conditions drawn up by the Direction of Ways of Communication.

China.

Nearly all parts of China are greatly in need of better facilities for supplying the people with pure drinking water. In all the city of Foochow, with its million of inhabitants there is not a single pump, windlass, or other mechanical appliance for raising water from wells or bringing it from the river to supply the city. There is no public water system in all Southern China.

Egypt.

The Egyptian Railway Administration is about to spend 3,000,000 Egyptian pounds on new works and materials. It is proposed to construct two lines, instead of the present single one, from Minieh to Wasta, at a cost of 600,000 Egyptian pounds; to extend all the lines on the system, chiefly the line to Rosetta, to build goods stations, etc.

ONE OF THE NEW RAILWAY FERRY BOATS.

THE GJEDSER-WARNEMÜNDE FERRY BOATS.

BY OUR BERLIN CORRESPONDENT.

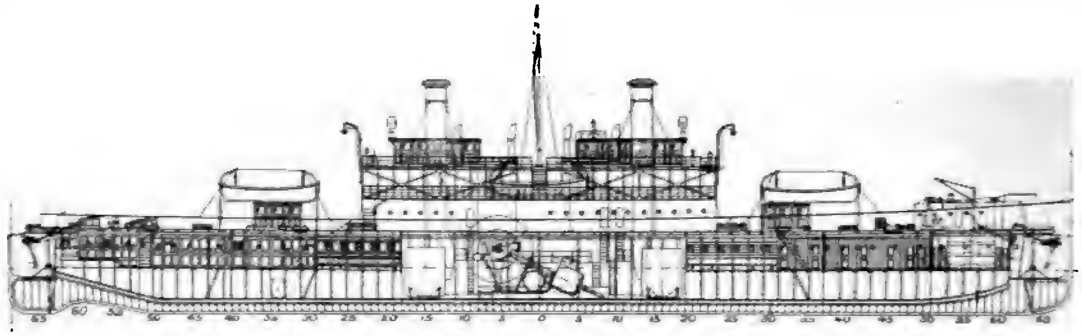
THE ferry boat line, 42 kilometres in length, between Gjedser, Denmark, and Warnemünde, Germany, which was opened on October 1st last year as part of the Berlin-Copenhagen railway line, comprises four ships, two of which belong to the Danish and two to the German State. Each country possesses a wheel steamer and a twin stern-screw steamer. The boats are provided on deck with rails intended for receiving whole railway trains, both with passengers and goods; the wheel steamers, having only one track, are specially intended for passenger service, whereas the screw steamers, provided with double tracks, will in the first place be utilised for carrying goods. In winter, however, during the ice period, the screw steamers are to be employed for the total traffic.

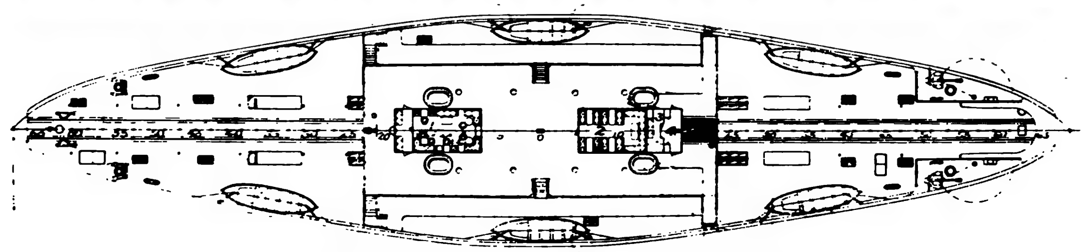
Travellers from the European Continent to Copenhagen and *vice versâ* are thus offered the advantage of being conveyed direct from Germany to Denmark without their being compelled to leave the train, and without their luggage having to be transhipped. The railway trains are led direct up to the ferry boats, to be conveyed over sea without the luggage being unloaded. Moreover, all the goods sent to Denmark and Sweden may now be carried direct on a much shorter way; in fact, the new line is more than 300 kilometres shorter than the existing ferry boat line from Jutland to Seeland, thus admitting of a material saving both in time and freight. In order to maintain the ferry-boat service throughout the winter, the screw ferry boats are designed as particularly powerful ice breakers, capable of clearing the ice obstructing the harbour under any circumstances.

Of the four boats above mentioned, three were built by the firm of F. Schichau, Elbing. These ships are made from the best class Siemens-Martin steel, in accord with the regulations of the German-Lloyd. The main deck is closed in front by a forecastle, provided with a mechanically moving passage for railway cars. In this way the boats are enabled to sail as soon as the railway cars have been transported on board the ship. On arriving, the train may immediately be transported on land through the movable forecastle, and can at once proceed on its way. The length of track is about 80 metres in the wheel boats and 125 metres in the screw boats, the ferry boats thus being able to receive "D-trains," passenger or freight trains of corresponding length. As the ferry boats are not able to turn round inside of the harbour, they are specially equipped in order to leave the latter backwards and to turn outside of it.

The two wheel boats have a triple expansion steam engine each of 2,500 i.h.p., developing the power necessary to drive the ship at the speed of 13·5 knots at about 45 revolutions per minute, and a coal consumption of 0·75 kilogrammes per h.p. hour. The three steam cylinders are arranged one beside the other, the low-pressure cylinder being midway. The engines are provided with surface condensers, with air and circulation pumps, steam-reversing device, and the necessary feeding and Lenz pumps. The boiler plants comprise four cylindric ship boilers each, two of which are located in each vessel in a common boiler room. For cases of emergency a small vertical boiler is provided.

The machine plant of the screw boat *Mecklenburg* consists of two vertically arranged triple

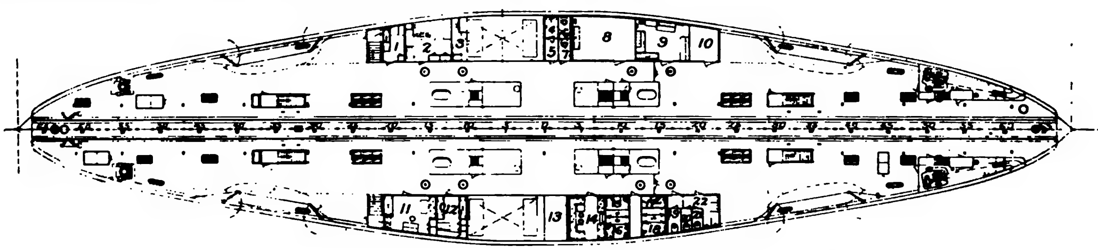




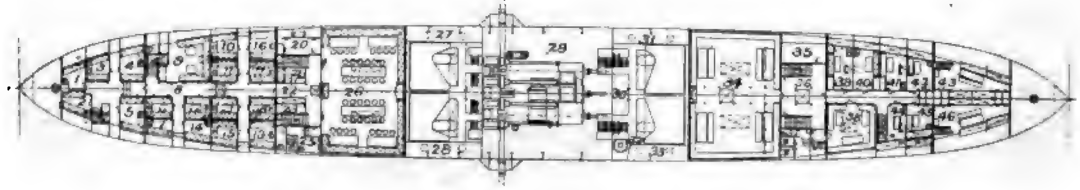
1. Ladies' Saloon.
2. Smoking Room (1st and 2nd class).
3. Chart House.
4. Rudder House.

expansion machines, developing a total amount of about 2,500 i.h.p., with about 80 revolutions per minute, and a consumption of coal of 0·75 kilogrammes for i.h.p. hour. The boiler plant comprises two cylindric double boilers, designed and arranged in the way usual with ships, being installed in a common boiler room in front of the machine room. There is also a small vertical boiler for emergency purposes.

The boats are lit by electricity throughout, two projectors serving to illuminate the sea at night.



1. Cook.
2. Kitchen.
3. Pantry.
8. Luggage Room (18 sq. m.)
9. Letter Room.
10. Luggage Room (6 sq. m.)
11. Captain.
12. Three Kitchen Girls.
13. Lamp Room.
14. Smoking Room.
15, 16, Custom House Office.
17, 18, Railway Officials.



1, 2, 3, etc. First and Second-class Passenger Cabins.
9. Ladies' Saloon.
20. Pantry.
21. Steward.
23. Stewardess.
26. Dining Room (1st and 2nd class).
27, 28, 31, 32. Coal.
29. Machine Room.
30. Boiler Room.
34. Saloon (3rd class).
35. Pantry.
38. Ladies' Saloon.
39, etc., etc. Machinists, Stokers, Sailors.

A FLOATING EXHIBITION.

WE have pleasure in calling attention to the Imperial Floating Exhibition—a novel idea which has been formulated with a view to the development of British trade abroad.

The idea, as set forth in an interesting little brochure, published by the Manager of the Exhibition, Mr. John Henderson, is to charter a large steamer, fit her out with samples of goods manufactured by the best British industrial firms, and send her on a voyage round the principal ports of the Empire, China, Japan, and, possibly, one or two other countries important as markets for British products.

Accompanying the steamer will be a representative of each firm exhibiting, and a competent staff of officials for organising and carrying out the details of the tour. A fixed amount of clear space will be set aside for each participant. At each port of call the Exhibition will be "opened" by a prominent official, and the members of the local Chambers of Commerce, the leading traders, and others are to be entertained on board. Advance agents of the Exhibition, assisted by the local press, will see that the advent of the Exhibition is made widely-known throughout the trading community of each country.

AUCKLAND.

VICTORIA BRIDGE, BRISBANE.

The objects the organisers have in establishing the Exhibition are: (1) The promotion of inter-Imperial commerce; (2) The personal introduction of the seller to the buyer; (3) To provide a means by which British manufacturers can fully investigate the peculiar conditions and requirements of individual markets. (4) The advertisement of British industries by bringing to Foreign and Colonial ports a representative Exhibition of British manufactured articles.

We gather from the pamphlet that limited space will prevent the appropriation of accommodation by two firms representing the same trade. As it seems to us that this would somewhat circumscribe the limits of the Exhibition, we are glad to note that it has been decided to make exceptions to this rule, when it is found impossible to discover one firm capable of adequately representing a particular industry in all its branches. "In such cases," writes Mr. Henderson, "a certain space (necessarily small) will be allotted to the trade, and various manufacturing houses will combine to make the show thoroughly representative."

We are also informed that the steamer to be chartered for the purposes of this Exhibition is the *Lake Megantic*, a North-American liner of some 5,500 tons. The Exhibition ship will probably sail from London during September. There is no doubt but that the Exhibition will be watched with great interest. The accompanying illustrations from the brochure show three of the numerous ports of call.

NAGASAKI HARBOUR.

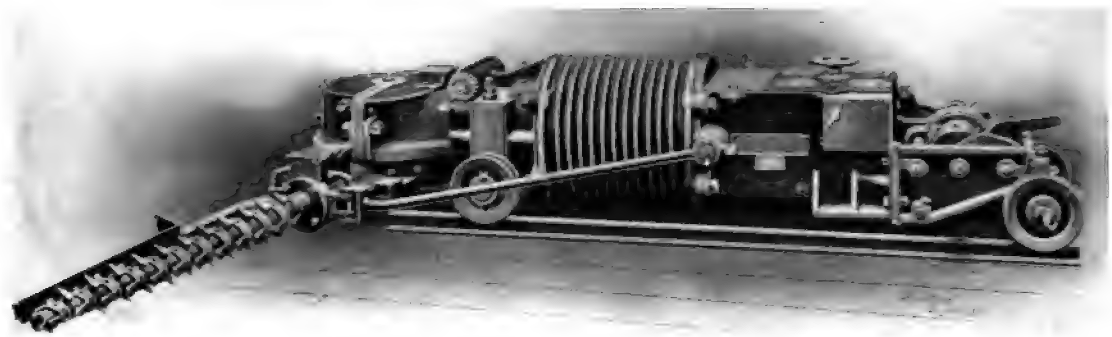


FIG. I. THE PICKQUICK ELECTRIC BAR COAL-CUTTER, WITH ALTERNATING CURRENT ELECTRIC MOTOR, ADJUSTED FOR UNDERCUTTING.

COAL CUTTING BY ELECTRICITY.

IN view of the recent report on the employment of electricity in mines, the "Red Book," issued by Messrs. Mavor and Coulson, Ltd., possesses peculiar interest for colliery owners and managers. It is concerned with Pickquick coal-cutting machines fitted with direct current electric motors, three-phrase motors, and compressed air motors. It is pointed out that the long wall method of working is better suited than any other for machine mining, and is favourable to a large output per machine.

The economies effected by machine mining are summarised as follows:—

(1) The cost of holing is reduced by the large increase of output per man employed.

(2) A large output is obtained from a relatively small face, and the extent and cost of maintenance of roads is reduced.

(3) The cost of timbering is reduced, and the straight and rapid advance of the face facilitates the breaking away of the coal.

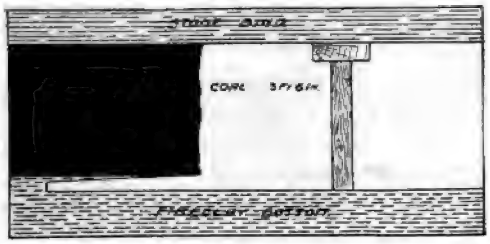
(4) The use of explosives is almost invariably reduced, and is frequently abolished by machine holing.

(5) The percentage of slack is reduced, and the sale price of the coal is substantially increased.

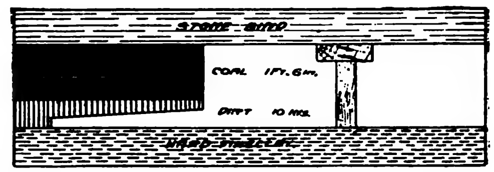
(6) Greater safety to the miner. The machine does the most dangerous and laborious part of the miner's work, and the systematic timbering imposed by machine holing reduces falls at the face, and diminishes the number of accidents and compensation claims. The ratio of accidents to tonnage output has proved to be much lower with machine-cut than with hand-holed coal.

The writer remarks that when the system of electric supply is open to choice, direct current should be selected, as it is the best adapted for driving coal-cutters. When the adoption of alternating current is determined by other considerations, a low periodicity, not exceeding 30 cycles per second, should, if possible, be used. The limitations in respect of diameter, speed of rotation, and complete enclosure of coal-cutter motors are incompatible with the best design in alternating-current motors for higher periodicities. The application of alternating-current motors with closed circuit rotors to the larger sizes of bar coal-cutters for use in thick and medium seams presents little difficulty when the periodicity does not exceed 30 cycles per second, but for the small size machines the use of alternating current is impracticable. Where the supply is alternating it is therefore necessary to interpose rotary converters, or motor generators, in order to transform to direct current for the small machines.

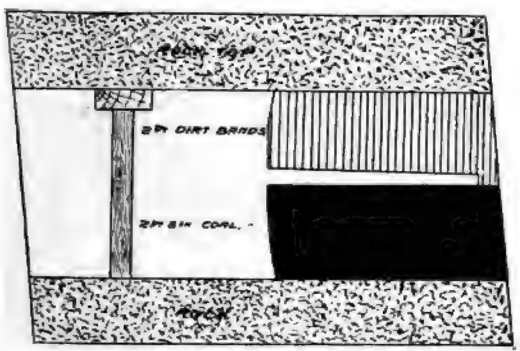
The five parts which make up the Pickquick, viz., the cutter bar, gear head, motor, switch box, and hauling gear, are described in detail, and some interesting diagrams (reproduced herewith) show specimen seams worked by this cutter. We also reproduce a view of the machine fitted with alternating current electric motor, and adjusted for under-cutting.



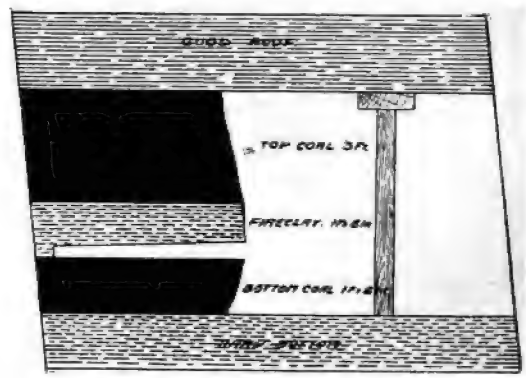
Depth, 600 ft. Fireclay Holing.
Undercut, 4 ft. deep.



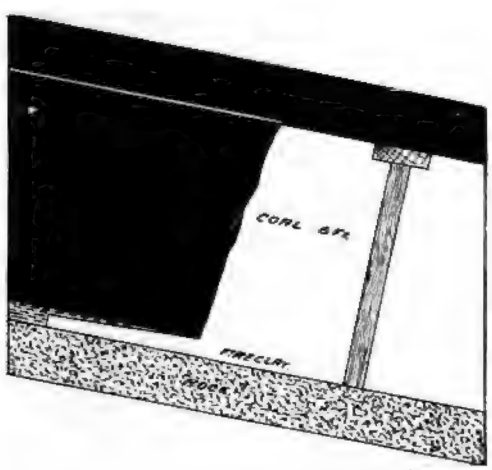
Depth, 800 ft. Coaly Band Holing.
Undercut, 4 ft. deep.



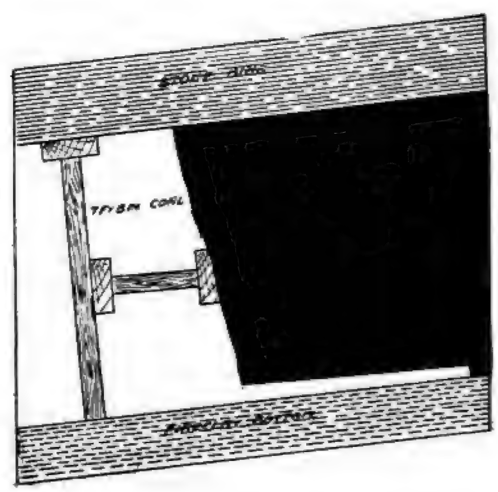
Depth, 1,500 ft. Inclination of Face, 1 in 10.
Dirt Band Holing. Undercut, 5 ft. 6 in. deep.



Depth, 1,200 ft. Inclination of Face, 1 in 9.
Fireclay Holing. Undercut, 4 ft. deep.



Depth, 2,200 ft. Inclination of Seam, 1 in 5.
Hard Fireclay Holing. Undercut, 4 ft. 6 in. deep.



Depth, 2,000 ft. Inclination of Seam, 1 in 10.
Coal Holing. Undercut, 6 ft. deep.

FIG. 2. SEAMS ILLUSTRATING THE WORKING OF COAL CUTTING BY MACHINERY.

A GUIDE-BOOK TO MINING.

Notes on Professor Le Neve Foster's New Text-Book on "The Elements of Mining and Quarrying."

SIR C. LE NEVE FOSTER, D.Sc., F.R.S., has rendered his new text-book,* on the "Elements of Mining and Quarrying," additionally attractive to students by the inclusion of a number of engravings illustrating mining operations as they are actually carried on. One of these shows the use of the wire saw at Maillou Slate Quarry, Labassère, near Bagnères-de-Bigorre, France. Vertical and horizontal cuts are made by the saw, but in the illustration (fig. 2) the horizontal cuts are covered by rubbish.

"The most novel method of cutting stone," says the author, "is one which is in use at marble quarries in Belgium, Carrara and elsewhere. It consists in sawing grooves by an endless cord, composed of three steel wires twisted together, which travels on the rock, and is supplied with sand and water. Fig. 1 represents the arrangement adopted at the Traigneaux Quarry, near Philippeville, Belgium. A, B, C, D, E, F, is the wire cord travelling in the direction shown by the arrows; G and H are the two pits which have been sunk to hold the pulley frames. When the cutting process began, the wire cord would have been running along the line IJ; the groove is gradually deepened until it reaches the line K L. After suitable vertical cuts have been made, the block is severed horizontally by means of wedges." Fig. 2 shows the kind of work done by the wire-saw in the Pyrenees.

Discussing other methods of excavation, Professor Le Neve Foster remarks that a machine which will excavate a complete tunnel at one operation has long been a desideratum of the miner. Stanley's machine cuts an annular groove in coal by teeth attached to a cross-bar, which is made to revolve by a compressed air engine. Much of the cylinder of coal within the groove breaks off while the cutting is going on, and what remains can easily be brought down by a single central blast.

With regard to shaft-sinking machines he remarks that in exceptional cases shafts are being sunk by the aid of machines which will cut out a big circular pit. As in the case of small holes, the work may be done by rotation or percussion. Rotary machines are being employed in Germany in some sinkings through quicksand; the machines are big revolving scoops, and several ingenious contrivances have been designed for promoting the speed and success of the operations. Large percussive tools similar in action to those employed in exploratory borings, enable shafts 16 ft. in diameter to be excavated through watery strata without any pumping being required, and the names of Kind and Chaudron will always be associated with this method of sinking. Sutcliffe advocates the use of a machine which will cut a circular groove round the circumference of the proposed shaft, just as Stanley's machine cuts a groove for driving a level. When once a peripheral groove has been made, it is easy to blast away the core.

In addition to such practical illustrations as these there are, of course, many valuable figures and diagrams, and the text is arranged so clearly and scientifically that the work becomes literally what the author intended it to be, viz., a guide book to mining. Professor Le Neve Foster first makes the way easy for the student, and then tells him to diligently visit

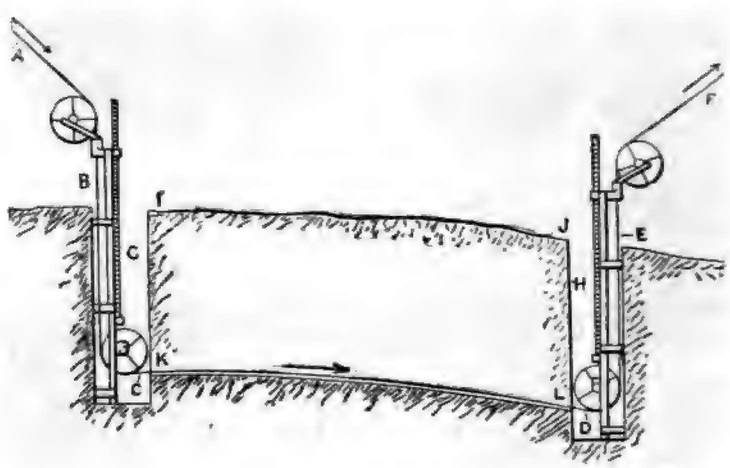


FIG. I. WIRE SAW, TRAIGNEAUX MARBLE QUARRY, PHILIPPEVILLE, BELGIUM.

* "The Elements of Mining and Quarrying," by Sir C. Le Neve Foster, D.Sc., F.R.S. 7s. 6d. net. Charles Griffin and Co., Ltd.

mines. "A book on mining," he says, "aids the student in acquiring information, explains points which may be obscure, and suggests subjects for inquiry, but without in any way enabling him to dispense with the knowledge which comes from seeing and doing things." The illustrations, nearly three hundred in number, should certainly encourage the student to carry out the excellent advice given.

The work is divided as follows: Occurrence — Discovery — Boring — Excavation —Support—Exploitation —Haulage—Hoisting or Winding— Drainage — Ventilation — Lighting — Access—Dressing—Legislation— Condition of the Workmen—Accidents.

The chapter on legislation is included because mining differs from most other occupations by being regulated by special statutes, and it is especially with an uncongenial branch of the subject like law that the student needs a helping hand. The subject is briefly dealt with as follows:—(1) Classification of mineral workings in the United Kingdom. (2) Statutes relating solely to mines and quarries. (3) Certain statutes affecting mines and quarries incidentally.

The inclusion of a chapter on the condition of workmen in an elementary text-book may surprise some, but the author says he considers that the labour question is of so much importance that the student should have his attention directed to it at the very outset of his career. In this chapter are briefly discussed:—(1) Conditions of labour, (2) Clothing, (3) Housing, (4) Occupational Diseases, (5) Hospitals, (6) Education, (7) Recreation.

FIG. 2. MAILLOU SLATE QUARRY, NEAR BAGNÈRES-DE-BIGORRE, FRANCE.
Where vertical and horizontal cuts are made by the wire-saw.

Professor Le Neve Foster's work offers a marked advance in the preparation of mining text-books, and can scarcely fail to be of corresponding benefit to mining students.

Since the completion of these pages we hear with deep regret of the death of Professor Le Neve Foster, which occurred in London on the 19th ult.—Ed.

NOTES and NEWS.

A New Way of Tapping Water Mains.

A PROCESS valuable to waterworks engineers was recently tested in a practical manner at Snaresbrook, when, by means of the Smith tapping machine, a 24 in. water main belonging to the East London Water Company was tapped and a 12 in. branch attached to it without any interruption of the supply. The main was at the time fully charged at a pressure of about 54 lb. to the square inch.

A 24 in. cast iron collar, made in two halves, was first bolted around the main. On one side of this collar was cast a 12 in. outlet, and on the inside of this outlet a clay roll was inserted, the half-inch space between the collar and the pipe being then filled with lead, and thoroughly calked. The joint inside the 12 in. outlet was calked last, this joint being relied upon to make the collar watertight. To the outlet was then attached a 12 in. valve, having a bayonet joint for connection to the collar. This joint was poured with lead, and calked in the ordinary way. The valve had a flange on the other end, and to this flange the Smith tapping machine was attached. The door of the valve was then opened, giving a clear way of 12 in. in diameter. Through this valve the shaft carrying the 12 in. cutter and centre drill was then pushed forward until the centre drill touched the external surface of the 24 in. pipe.

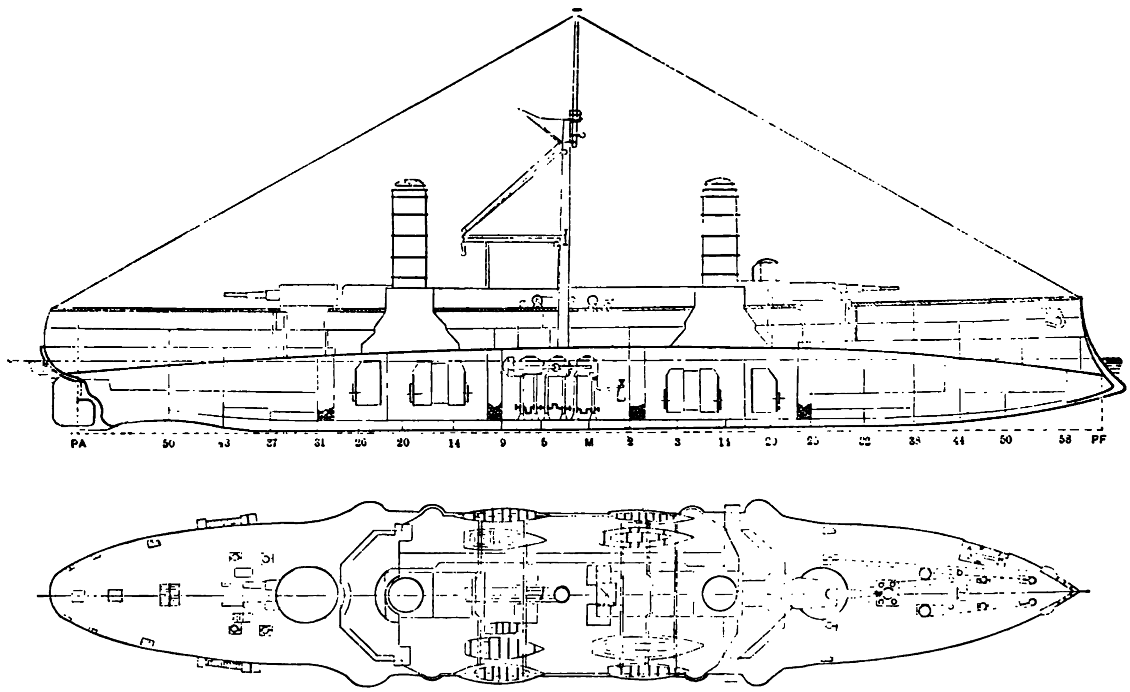
The shaft was then locked to the feed gear, and the operation of cutting the 12 in. disc from the 24 in. main was begun. The shaft of the tapping machine passes through a stuffing box to prevent the water escaping after the cut is made. The cutter was rotated by means of levers, and fed forward until the 12 in. disc was completely cut from the main.

THE SMITH TAPPING MACHINE

The centre drill shown in cut first pierces the main, and has the effect of centreing the large cutter and holding it firmly in position. As soon as this drill pierces the pipe the water, of course, rushes into the valve and the body of the machine, but cannot get any further, owing to the stuffing box, through which the shaft of the machine works. This water has the effect of lubricating the teeth of the cutter. On the end of the drill there is a thread, which forms a female thread in the cast iron disc that is cut out of the main, thus preventing the disc from dropping into the 24 in. main. The only way that the disc can be removed from the cutter is by unscrewing it. Owing to the curvature of the pipe it will be appreciated that the hole cut has really a larger capacity for the flow of water than if it was cut from a perfectly flat surface. In other words, if this disc is flattened, it would really measure more than 12 in. from top to bottom.

When the cast iron disc had been completely cut from the main, the shaft, together with cutter and cast iron disc, were withdrawn through the valve to the back of the valve door. The valve was then closed, enabling the workmen to unbolt the machine from the valve and remove it without the loss of water. After the machine was removed the valve was partially opened, in order that the borings from the cutter and drill might be removed by taking advantage of the strong flow of water. The cast iron collar and valve remained permanently attached to the main, leaving the flanged end ready to receive the new branch main. The entire operation was in every way successful, and required only one and a half hours.

The advantages of the new method are, of course, obvious. They include the avoidance of suspending the water supply, with its serious risks in case of fire, to say nothing of the danger of fracturing the main which attended the old-fashioned way of pumping the main dry at the point affected and cutting out a section with hammer and chisel. The process is far more expeditious, and is reported to be cheaper. For the above details we are indebted to Messrs. Clark W. Harrison and Co., of 72, Fenchurch Street, London, who are introducing the machine into this country. We understand that connections have been successfully made as large as 36 in. diameter to a 48 in. main, and against a pressure as high as 190 lb. to the square inch.



ELEVATION AND UPPER DECK PLAN OF THE NEW JAPANESE PROTECTED CRUISERS "KASUGA" AND "NISSHIN" (FORMERLY "RIVADAVIA" AND "MORENO"), PURCHASED FROM ARGENTINA.

Japan's Latest Cruisers.

The armament comprises one quick-firing 10-in. gun placed in the forward barbette, on the *Kasuga*, and two 8-in. guns, similarly mounted on the *Nisshin*; two 8-in guns in the after barbette, and fourteen 6-in. rifles. The secondary battery includes ten 3-in. rapid-firing guns and four above-water torpedo tubes.

The Chloride Electrical Storage Company, Ltd., are now supplying their new negative known as the "Exide." This plate embodies several important improvements in design and detail. The firm are also sending out a new type of board separator, which takes the place of the glass rod separators formerly employed, and prevents any short circuiting from plate to plate.

The Borough Council of Battersea has lately placed with Messrs. Mather and Platt, Ltd., of Salford Iron Works, Manchester, an order for a second electrically-driven pump for drawing the necessary condensing water from the Thames and lifting it to the tank on the top of the engine-house. The pump is of Mather and Platt's high lift turbine type, No. 7 size, capable of delivering a maximum of 100,000 gallons of water per hour, which, however, may be reduced to half that amount when desired. The total head will vary 50 to 60 ft. according to the state of the tide in the river. The pump is driven by an entirely enclosed steel-clad motor of 60 b.h.p. taking current at a pressure of 460 to 520 volts. The contract includes all the piping and valves, both suction and delivery and the starting and regulating switches, and the whole plant is a duplicate of that supplied by the same firm and put down some time ago.

Among the electrical contracts recently secured by the British Westinghouse Electric and Manufacturing Company, Ltd., are the following: Twelve 50-kilowatt and six 18-kilowatt transformers for the South London Electric Supply Corporation; twelve 50-kilowatt transformers for Coventry Corporation; a contract for the supply of meters for twelve months for the Borough of Islington; and the supply of single and poly-phase meters for twelve months for Sydney Corporation.

A contract has been placed by the County Council of Lanark with Meldrum Brothers, Ltd., Manchester, for one of their 3-grate "Simplex" Refuse Destructors with suitable boiler plant, to be erected at Cambuslang.

Messrs. J. and J. Charlesworth, Colliery Proprietors, of Wakefield, have placed a large order for a complete coal screening plant, including the whole of the steel structural buildings, roofing, picking belts, tipplers, etc., having a capacity of 3,000 tons per day, with Messrs. Graham, Morton and Co., Ltd., this plant is for their Kilnhurst Pit, Rotherham.

Messrs. Graham, Morton and Co., Ltd., are also constructing nine bridges, to be erected between Boston and Grantham on the Great Northern Railway, and two bridges to be erected in London for the South-Eastern and Chatham Railway.

The British Westinghouse Electric and Manufacturing Company, Ltd., have just received an order from the Erith Urban District Council for a 500-kilowatt three-phase engine-type alternator to operate at 3,000 volts 50 cycles.

NEW TYPE OF FIRE BOAT BUILT FOR MESSRS. HUNTLEY AND PALMER.

A Novel Motor Floating Fire Engine.

The petrol motor is specially well adapted for driving fire extinguishing machinery, and Messrs. Merryweather and Sons have already made several land engines, which have proved very successful. This firm has now completed a new type of fire boat, the hull being of steel, 32 ft. long, 9 ft. 6 in. beam, with a draught of 2 ft. 6 in. It will pass under a bridge 4 ft. 6 in. from water level, and has been built for Messrs. Huntley and Palmer's biscuit works at Reading, where it will be kept on the canal ready for work in case of fire.

The boat has two four-cylinder petrol engines, each of 30 h.p., and each driving a Merryweather patent "Hatfield" three-barrel pump at high speed. Each pump delivers 300 gallons per minute, and they can be run together or independently. The boat is propelled by water jets, two forward and two aft, controlled by levers on deck.

The full power of the pumps can be used for propulsion, or turned into the outlets on deck, from which six hoses can be worked at once or the whole delivery turned into one stream, for directing which a special "monitor" is fitted.

The ignition is on the high tension system, with duplicate batteries and coils. Suction for the pumps can be taken on either side of the boat. Large exhaust boxes are fitted at each side, giving very quiet running. Two revolving reels aft carry 1,000 ft. of hose, and tanks are provided for petrol for 10 hours' running. The trial was very successful, a big jet being thrown over 150 ft. high, and six streams, each about 80 ft., were projected simultaneously.

Following on the five 400 kilowatt sets, which Messrs. Mather and Platt, Ltd., of Salford Iron Works, Manchester, have already supplied for the Belfast Electricity Works—four in 1899 and one in 1900—they have now received the order for a sixth set, also of 400 kilowatt capacity, generally similar to the one supplied in 1900, but embodying several new and improved features in the design of both dynamo and engine. The engine is one of Belliss and Morcom's self-lubricating three-crank three-cylinder triple expansion type, running at 330 revolutions per minute, and designed to work either condensing or non-condensing with steam at 160 lb. pressure and superheated 50° F. The dynamo is a six-pole machine, compound wound to give a normal output of 400 kilowatt at voltages from 440 volts to 550 volts, and will be capable of standing an overload of 25 per cent. The yoke ring and poles are of cast steel, split horizontally; the armature is of standard type, with a drum winding in a slotted core. The machine is carried upon an independent bedplate provided with flanges for bolting up to a similar bedplate carrying the engine.

For the Inca Gold Development Corporation of Peru, Ltd., an electrically-driven gold dredger is to be built by Messrs. Lobnitz and Co., Ltd., of Renfrew, under the direction of their expert, Mr. T. Ross Burt.

Messrs. Newton Brothers, electrical and mechanical engineers, have removed their offices from Full Street to 21, Market Place, Derby.

The Melting Pyrometer.

This instrument has been introduced by the Horsfall Destructor Company, Ltd., for the purpose of ascertaining, within reasonable limits, the temperature in furnaces and flues where pyrometers of the kind at present upon the market are not entirely suitable. It may be admitted at the outset that the most correc instrument for such purposes is the well-known electrical pyrometer, which gives accurate readings, but which is in itself a delicate and expensive instrument, and one not likely to be entrusted to the ordinary workman or labourer. The instrument which we now illustrate is intended for rough commercial approximation, and consists essentially in the provision of a series of metals and alloys, which melt at temperatures varying from about 300 deg. F. to about 2,000 deg. F. These metals and alloys are arranged in separate small receptacles, in a small and handy case.

The method of working the melting pyrometer is as follows:—The temperature of the furnace is roughly judged, and a series of, say, eight metals is then placed in a regular sequence in a holder contained in the case, the metal having the highest melting temperature being placed in the top compartment of the holder. A printed list of the metals, giving their temperatures in Fahrenheit and Centigrade is provided, having columns ruled for the different tests which it may be desired to carry out. A note of the series put into the furnace is made by simply putting a cross at the highest and lowest metal employed upon the printed list. The instrument may then be entrusted to a labourer to take away and hang in the furnace at the point required for two or three minutes, when it may be brought back for reading. It is then obvious that the temperature of the furnace lies between the ascertained temperature of the highest metal which is found to be melted, and the ascertained temperature of the lowest metal which is found to be unmelted. Any person practised in judging temperatures can no doubt manage with a series of even three or four melting temperatures, instead of eight, which is the maximum allowed for in the holder.

The instrument is the outcome of a great deal of patient investigation and experiment, the great difficulty being to obtain suitable alloys with well-defined melting-points giving the required sequence. It should be useful to the users of all kinds of kilns, furnaces, and destructors, gas managers, and engineers, who are engaged in making boiler tests.

NEW MELTING PYROMETER
(Watson, James and Bullock's patent).

BORINGS FOR WATER SUPPLY.

MESSRS. MATHER AND PLATT, LTD., have just completed the contract for sinking two boreholes at the pumping station of the Wallasey Urban District Council, Sea View Road, Liscard, Cheshire.

This work was rendered necessary owing to the water level having fallen to such an extent that the existing pumps in the deep well could no longer be worked at their normal speed and output of 2½ million gallons per day.

The two boreholes are each 42 in. in diameter, and have been sunk from the bottom of the existing well, which is 12 ft. in diameter and 166 ft. deep, the one to a depth of 320 ft., and the other to a depth of 816 ft. from the surface. The working barrels of the pumps formerly placed at the bottom of the 12 ft. well have now been lowered down the boreholes to a depth of 250 ft. from the surface; and thus a sufficient supply of water is obtained for the pumps to work at their normal speed.

The borings have been successfully carried out in the face of exceptional difficulties, as owing to the confined space inside the pump house and the presence of the existing pumping machinery, it was impossible to use the ordinary pattern of boring plant; besides which one of the two pumps in the well had to be kept available for work at any minute in case of use.

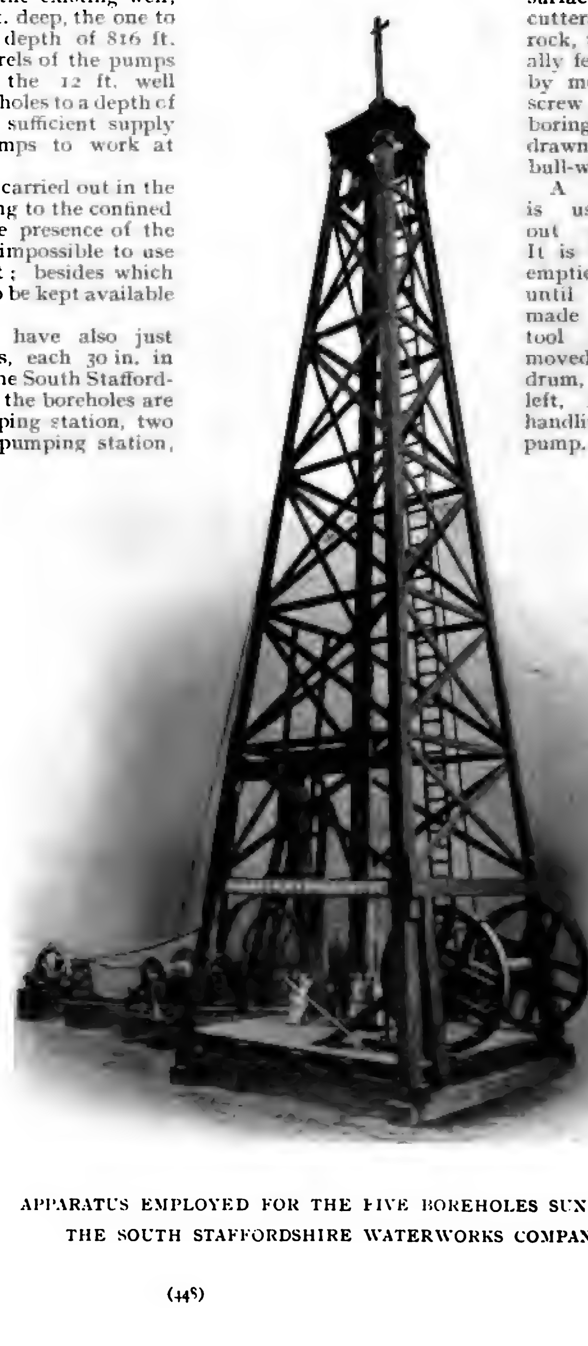
Messrs. Mather and Platt, Ltd., have also just received an order for five boreholes, each 30 in. in diameter and about 600 ft. deep, for the South Staffordshire Water Works Company, two of the boreholes are at the Lichfield (Trent Valley) pumping station, two at King Winsford for the Ashwood pumping station, and the fifth boring at a new station at Pipe Hill, near Lichfield.

Plenty of space will be available for the operations which are to be conducted for the South Staffordshire Waterworks Company, and consequently the ordinary round rope system will be employed. The improved form of apparatus is illustrated herewith, and is thus described:—

It consists of a timber erection or derrick about 60 ft. high, supporting a guide pulley at the top. On one side is arranged a hoisting barrel with bull-wheels, and on the other a walking beam. The latter is actuated by a connecting rod and crank, driven by a large belt-pulley from a steam engine. One end of the walking beam is connected by a round rope to a boring bar of great length and weight, the other end of the rope being coiled on the bull wheel shaft or barrel, which is fitted with a brake. The crank arm has several holes for the reception of the pin, to permit of various lengths of stroke.

The elasticity or spring of the rope permits of a rapid rate of working. The bar hangs some distance from the bottom of the hole, the distance varying from 6 in. to 3 ft. according to the length and consequent stretch of the rope. When motion is given to the walking beam, the heavy boring bar rises and falls in the hole with a periodic motion. The suspended weight stretches the rope until the cutters touch the bottom, when the whole rapidly rebounds. The bar is rotated by the borer twisting the rope at the surface; and as the cutters penetrate the rock, the borer gradually feeds out the rope by means of a long screw and nut. The boring tools are withdrawn by aid of the bull-wheel and engine.

A sludge pump is used to clean out the borehole. It is withdrawn and emptied several times, until all the debris made by the boring tool has been removed. A winding drum, shown on the left, is provided for handling the sludge pump.



APPARATUS EMPLOYED FOR THE FIVE BOREHOLES SUNK FOR THE SOUTH STAFFORDSHIRE WATERWORKS COMPANY.

The Civil Engineers' Visit to Hadfield's Steel Foundry.

SIR WILLIAM WHITE, K.C.B., LL.D., on the 20th ult., paid a special visit to the East Hecla Works of the Hadfield's Steel Foundry Company, Ltd., in company with other distinguished visitors and the Yorkshire Section of Students of the Institute of Civil Engineers. The party from London were conveyed by special train, which set the visitors down in the works, where they were received by Mr. R. A. Hadfield, chairman and managing director, General the Right Hon. Sir W. Brackenbury, Colonel Sir H. Vincent, M.P., Mr. B. Freeborough, Mr. Alex. M. Jack, directors, and Mr. Dixon, secretary.

Amongst those also present were: Admiral H. J. May, C. B., General Wace, C.B., member of the Ordinance Committee; Colonel Hadden, C.B., Director of Artillery; Colonel Pease, of the Ordinance Committee; Mr. H. T. de la Bère, C.B., Director of Army Contracts; Colonel Holden, superintendent of the Royal Gun Factory, Woolwich; Lieutenant-Colonel J. de Manzanos, Military Attaché to the Spanish Embassy; Captain Diaz, Naval Attaché, Spanish Royal Naval Commission; Mr. R. Kaye Gray, President of the Institution of Electrical Engineers; Sir Edward Carbutt, past president of the Institution of Mechanical Engineers; Sir George Bruce, M.Inst.C.E., Professor W. C. Unwin, of the City and Guilds Central Institute; Professor Arnold and Professor Ripper, of University College, Sheffield; Major Wooley-Dod, Mr. A. F. Yarrow, M.Inst.C.E., Mr. J. A. MacDonald, chief engineer to the Midland Railway; and Mr. F. Wooley-Dod, of the Commission of Indian State Railways; Mr. W. McDermott (director of Messrs. Fraser and Chalmers), etc.

PROJECTILES, etc.

The centre of attraction on arrival at the works proved to be an assortment of Hadfield's improved steel projectiles of all types, as manufactured at the Hecla Works, from 12-pounders to 13·5 in., weighing 1,250 lb. each; including the latest type of armour-piercing shell. In the Machine Shop, a quantity of rock-breaking machinery was inspected; also a group of machined special steel castings and forgings for the River Tyne High Level Bridge (North Eastern Railway Co.) electric tramway-car wheels and axles, etc.

THE LUNCHEON.

At the luncheon, Mr. R. A. Hadfield (presiding) first proposed the usual loyal toast, and incidentally mentioned that His Majesty the King has been an honorary member of the Institute of Civil Engineers for thirty-six years, and is also a patron of it.

The Chairman then gave the toast of the "President of the Institute of Civil Engineers — Sir William White"—remarking that the Institute had over 8,000 members, and was the largest institution of technical and professional men in the world. Its respected president had much in common with Sheffield, which city had done its best to help him to construct those magnificent ships of war with which his name was associated throughout the world. The "price of Admiralty" as Kipling had said, was indeed heavy at times, and they had had the fact illustrated out in the East quite recently. It was such a man as Sir William White who had made Admiralty possible to England. Referring to the establishments of the firm, Mr. Hadfield said it would unfortunately not be practicable for the party to visit the old Hecla Works, which were 1½ to 2 miles distant, where they made their shot and shell. As regarded the East Hecla Works, where they were, the site of those works 5½ years ago was practically an unploughed field; to-day the works sent out products of all kinds for the engineering and mining and other industries, and the party would be able to inspect most of the departments in full work. He specially invited the attention of visitors to the mechanical testing of various kinds of steel and alloys, also to photographs showing the micro-structure of the metals, and to the various processes by which they sought to improve their products.

Sir William White, who had a very cordial reception, expressed the sense of obligation felt by himself and by the members of the Institute of Civil Engineers for the extreme kindness and warm hospitality shown them by the firm of Messrs. Hadfield. On behalf of the Institute, and particularly of the Yorkshire and Newcastle Associations of Students of the Institute, he desired to express most sincere acknowledgments. In coming there they were visiting works of which the country might well be proud. He had known them in their earlier form, but he had not until that day been able to come to see the new and extended works. He was intimately acquainted with the work which had been done by Mr. Hadfield now for many years in connection with the scientific development of the manufacture of steel, a most remarkable personal achievement, and he felt that the members of the Institute would desire him publicly to express the admiration which all engineers not merely in this country, but throughout the world felt for the researches that he had undertaken, and the wonderful and remarkable results that he had obtained. They would see during their visit a great

[illegible] as examples of the circumstance that Mr. Hadfield in his own person united the manufacture of steel and the user of steel; therefore, he knew by personal experience what users of steel required, and as a manufacturer he had provided every [illegible] in the form required most efficiently to fulfil the conditions of the special problems to be faced. But Mr. Hadfield was more than that; he was recognised by men of science throughout the world as a [illegible] as to be included in their own ranks. He [illegible] may [illegible] to Mr. Hadfield's presence, [illegible] he would say, that though Mr. Hadfield's [illegible] for the Royal Society was not successful [illegible] it was a consolation that, in his opinion, [illegible] in the early future, so that metallurgical [illegible] would have the honour of including another [illegible] in the lists of that famous society in the person of Mr. Hadfield. The Council of the Institution of Civil Engineers had signalised their [illegible] of Mr. Hadfield's professional activity [illegible] by including his name in the list of candidates for membership of their body, and he (Sir William White) hoped that after the election a week [illegible] Mr. Hadfield would be a member of the Council of the Institute of Civil Engineers. [illegible] and for years in season and out of season, been [illegible] for the closer association of practical manufacture in this country with scientific research. It [illegible] in that manner much more than by mere laboratory [illegible] that the advances which had been made in [illegible] would be equalled or exceeded in the future. [illegible] Mr. Hadfield they had a pioneer in that direction; [illegible] for many years, in the scant leisure of a busy [illegible] life, had devoted himself to scientific [illegible] of the highest order. Mr. Hadfield's productions in regard to the alloys of iron with manganese, [illegible], nickel, and most lately, with tungsten, [illegible] works of the highest order, not merely to metallurgists, but to all who were interested in the development of the applications of chemistry in manufacture. [illegible] the visitors would see had been arrived at by [illegible] or accidental discoveries, but was the result [illegible] and organised research. He trusted that the example which had been set here and elsewhere in this country would be very generally followed, and that the means which had produced the high [illegible] of German manufacturing and commercial [illegible] at the present time would no longer be chiefly [illegible] in that country, but that it should cease to be true that researches originated in this country, and carried to effect here on the scientific side, were, on the practical side, applied and developed abroad. In conclusion, Sir William White said he was asked to add to the expressions of thanks and indebtedness to the firm which he had already made, similar expressions on behalf of the eminent Spanish military officers who were present with them, also on behalf of the representatives of the War Office, and that patriarch of his own profession, Sir George Bruce. He proposed "Success to the firm of Hadfield and Company: long may it flourish." [Applause.]

A TOUR THROUGH THE WORKS.

Moulding in all stages occupied the attention of the visitors on the resumption of the inspection, after which an adjournment was made to the tramway and railway lay-out department—a large open space of about five acres, on which the ground is covered with timber baulks to form a flooring, whereon junctions, points, and crossings of electric tramway and railway lines are laid out in all their intricacy to suit the special positions for which they are being constructed. The most instructive feature of the afternoon and possibly the best appreciated was the firing of specimen capped and uncapped projectiles of Hadfield's make against a steel armour-plate, the effect of these capped projectiles as described and illustrated in detail in PAGE'S MAGAZINE* being completely demonstrated. The projectiles known as the Heclon armour-piercing capped shells are 4½ in. diameter, and weighing 31 lb. They can be fired from a Krupp gun capable of giving velocities up to 2,800 foot seconds (equal to a range of 17 miles), with a striking energy up to 1,[illegible] foot tons, which would perforate 11½ in. of wrought iron. The shells were actually fired at a 4 in. steel plate, with a velocity of 1,850 foot seconds, and a striking energy of 738 foot tons, capable of perforating 8½ inches of wrought iron. The shots were fired electrically, the party meanwhile being sheltered in a heavily earthed and timbered enclosure. The uncapped projectile was badly smashed, while the projectile with the soft cap passed right through the target practically undamaged.

After the party had been photographed in a group, the Foundry Track Work Department, Machinery and Finishing Shop, Power Station, and the Annealing, Fettling, and Grinding shops were successively visited.

Visitors specially interested in the testing of materials then proceeded to the Testing Room, where the 100-ton Whitworth Testing Machine was working on tensile and compression tests on several of the numerous special grades of steel manufactured at East Hecla Works, including Hadfield's patent "Era" manganese steel, special mild steel for locomotive wheel centres, special high elastic limit steel, etc.; also drilling and other tests on this steel. An exhibition of research instruments, included permeability and hysteresis testing instruments, pyrometers for registering high temperatures.

The Smiths' Shop, Colliery Truck Building, Machine Shops, Pattern Shop, and Test Room also claimed attention.

Although the Company are primarily steel founders, forgings for all branches of engineering work are produced. The visitors had also an opportunity of inspecing ore-breakers, screening plants, elevators, and conveyors for ore and coal, etc., in process of construction.

The management has always made a point of providing special steel for different classes of work, according to the mechanical properties needed for the working conditions. These conditions are extremely various. This system of working has necessitated an extensive laboratory and scientific staff, both for chemical and physical tests. This is a special feature to which Mr. R. A. Hadfield has always given particular attention, and it has been responsible for the special grades of steel which have gained the firm a world-wide reputation. The most prominent and best known amongst engineers is the Hadfield's "Era" manganese steel, which is so hard that no steel tool will cut it, while, at the same time, it is so tough that pieces half an inch thick can be bent nearly double cold without cracking.

* "The Gun v. The Armour Plate," by John Leyland.—October 1902.

MONSIEUR DU BOUSQUET AND HIS WORK.

AN APPRECIATION.

BY CHARLES ROUS-MARTEN.

A Great French Engineer.

It has, I believe, been mentioned by me already in these "Notes" that there exists a curious controversy or dispute, or rivalry—none of these is the word I want, but the English language does not seem to supply the right one—touching the question to whom is due the chief credit for the now-famous de Glehn compound locomotives—M. de Glehn himself, or M. du Bousquet? The dispute consists not in the desire of M. de Glehn on the one hand, or M. du Bousquet on the other, to claim for himself the sole or even chief credit, but in the generous eagerness of each of these two distinguished engineers that an undue share of the credit shall *not* be awarded to himself, but that the fullest possible share shall be allotted to the other. A generous emulation of this sort is, perhaps, not commonly found in any profession; it is honourable in the highest degree to both gentlemen. But the circumstances of the introduction of the de Glehn system are specially creditable in another way to M. de Bousquet, the Chief Mechanical Engineer of the French Northern Railway. At the time it was first brought forward by M. de Glehn, M. du Bousquet, who had recently succeeded to his present position as head of the Locomotive, Coaching and Wagon Departments of the Chemin de Fer du Nord—his precise title being "Ingénieur-en-Chef du Matériel et de la Traction"—had himself devised a system of locomotive compounding which seemed to promise good results. Very few men indeed in his position could or would have resisted the temptation to introduce his own design, at any rate tentatively. But M. du Bousquet placed the interests of his company before all else, and, having convinced himself of the merits of the de Glehn method he first tested it thoroughly, and then definitely adopted it, with results which are of world-wide celebrity.

Du Bousquet *versus* de Glehn.

As most engineers are aware, it fell to my privilege to be the first to introduce the de Glehn compounds to the notice of this country. Until I happened to go to Paris, seven years ago, on a purely non-professional visit, I merely knew—as did others of my profession in this country—that there were such things as compound express locomotives on the French railways, but of their work or capacity I knew virtually nothing. Consequently, I went over with an entirely open mind. My initial run, Calais to Paris, in a train timed as fast as is any British train—with only two or three exceptions—for the same distance, with a load of 20 coaches, a compound engine, No. 2.158, made up something like 18 minutes, and climbed gradients of 1 in 125, 1 in 135, and 1 in 200, as I had never before seen them climbed with such a load, came as an absolute revelation to me. It set me at once upon a series of experiments which have continued ever since at intervals to this day. M. du Bousquet gave me most courteous and extensive assistance, including access to all information and the frequent use of a dynamometer-car and a staff of able assistants. The results, which I have published from time to time, were such as to prove conclusively that the de Glehn compounds which M. du Bousquet was procuring in large and increasing numbers, were doing work such as had never before been authentically recorded, at any rate on this side of the Atlantic. But several of the leading British engineers personally admitted to me that the figures were as complete a revelation to them as to myself. At a very early stage of my investigations M. du Bousquet urgently impressed upon me that the credit of the system of compounding which was employed must not be given to him, but was due to "Monsieur de Glehn, a compatriot of your own," as he put it. On the other hand, M. de Glehn was equally emphatic in impressing on me that while he was the inventor of the actual system of compounding, yet he could not have succeeded in introducing it had it not been for the hearty and self-sacrificing co-operation of M. du Bousquet, including that gentleman's large adoption of it in his highest class of express engines. Surely a most generous and honourable rivalry!

Developments.

In its original shape the standard du Bousquet de Glehn compound locomotive was an eight-wheeled engine having the driving and trailing wheels coupled with a leading four-wheeled bogie. Practically in this form the type found its way to every other main line in France—the Etat, Orleans, Midi, P.L.M., Est, and Ouest. Then came the ten-wheeled developments, first in the 4-6-0 shape, as No. 1301 on the Midi and No. 3.121 on the Nord—types which proved most valuable as passenger expresses as well as on fast goods duty—and then in the 4-6-0 or "Atlantic" type which, so far has proved the climax of the system. The twin pioneers of this class, Nos. 2.641 and 2.642 of the French Northern Railway, were specially designed by M. du Bousquet to utilise in its fullest potentiality the de Glehn method of compounding, by employing the principle in a new locomotive designed particularly for swift running combined with great power of load-hauling and hill-climbing. The new Great Western engine "La France" is in all essential points, as I have previously mentioned, a virtual counterpart of M. du Bousquet's Nos. 2.641 and 2.642 of the Paris 1900 Exhibition, to which have since been added Nos. 2.643-2.675. Of their achievements I have recorded in these columns many instances which came under my own personal observation. They have yet to be surpassed by any engine so far built. Nor is there any reason to doubt the ability of "La France" to do everything that her French sisters have done whenever she is afforded the opportunity of doing so. Meanwhile, her design has been reproduced in a far larger class on the Paris-Orleans line, and the other ten-wheeled type—the six-coupled class—has similarly been enlarged in the newest engines of the Orleans, P.L.M., Est, and Ouest French lines.

An "Engine of all Work."

It is rather remarkable that, whereas this 4-6-0 type was originally adopted by M. du Bousquet for use on fast-goods and heavy passenger-excursion traffic, its capacities have gradually so expanded and multiplied in practice that engines of this—the 3.121 class—are now habitually employed not merely on trains of these two orders, but also in hauling many fast expresses on the one hand and heavy coal trains on the other. Shortly after they began regular work, M. du Bousquet courteously allowed me to have one of them experimentally on the best Calais express, which then left Paris at 9 a.m., with the result that the engine performed the fast running in all respects satisfactorily, gaining several minutes on each stage, and arriving perfectly cool at Amiens. Since that date these engines, which now number 105, may often

be seen on some of the swiftest expresses, and they never seem to have any difficulty in not only keeping booked time, but also in making up time when late. In the other direction, moreover, these locomotives have superseded the eight-coupled non-compound class on many coal trains which run from Lens to Paris. M. du Bousquet himself states that these six-coupled engines with leading bogies and 5-ft. 9-in. coupled wheels, actually haul coal trains weighing 910 tons behind the tender, the entire distance of 143 miles, in *exactly half* the time taken by the eight-coupled non-compounds with 4-ft. 3-in. wheels, which latter took 14 hours as against the 7 hours occupied by M. du Bousquet's compounds. This represents a very remarkable economy.

M. du Bousquet's Suburban Engines.

In each of the last two years M. du Bousquet has introduced a fresh locomotive novelty. The earlier one was a very fine twelve-wheeled double-bogie tank-engine for extended suburban service and semi-express work. This type has been largely multiplied, and is in extensive and very successful use. Its twelve wheels are distributed in three separate groups. There is a four-wheeled bogie at each end, and the two middle pairs of wheels are coupled. I may deal with this type more fully on another occasion than space limits will permit to-day. The other novelty is a tandem compound tank engine for urban and closer suburban work—mainly for the Paris Ceinture Railway, which needs capacity for very quick starting. Hitherto this has not been adequately attained by non-compound locomotives, but M. du Bousquet's new tandem compound seems to have fulfilled the requirements of the case very satisfactorily, and hence to have met, in a large degree, the objections entertained by myself and others to the use of compounds for trains that have to make frequent stops. This engine has two 13-in. high-pressure cylinders placed behind two 21¼-in. low-pressure cylinders. By an ingenious device, it is contrived that the low-pressure valve shall be always a little later in its travel than the high-pressure valve which allows larger admission and smaller compression in the low-pressure cylinders than occurs in the ordinary system. The six-coupled wheels are 5 ft. 3 in. in diameter, and the piston stroke is 23½ in. in length. Fifteen of these skilfully designed and very efficient engines—which weigh 62 tons in working order—are now at work with highly favourable results.

M. du Bousquet on Locomotive Compounding.

Never, perhaps, have the true advantages of locomotive compounding been set forth with more succinct lucidity than by M. du Bousquet in a letter which M. Sauvage has published in the very able and interesting paper that he read recently to the Institute of Mechanical Engineers. After stating that the original experimental compound which had been working on the Nord line for eighteen years, had shown an average saving of 6·39 lb. of coal per mile as compared with the ordinary locomotives, and expressing the opinion that the saving is mainly due to the reduced condensation in the cylinders, which accrues under the compound system, while the very slight increase in oil consumption and repairs are comparatively inappreciable, M. du Bousquet goes on to say: "The economy of coal for our company, which gets cheap coal on its lines, may appear of secondary importance. But it must be observed, and that is of chief importance, that the economy is obtained only during a fraction of the total run. For instance, an ordinary goods engine running down grade with steam shut off, does not consume more than the compound in the same circumstances. In fact, the saving is obtained on the level parts and chiefly on rising gradients. The mileage corresponding to the saving is much below the total mileage. This saving for each kilometer of level or rising line is far superior to the average. . . . Important results are thus obtained; the daily mileage of locomotives, drivers, firemen, train staff, is greater; carriages and wagons are better utilised; piloting and supplementary trains are dispensed with." This puts the case in a nutshell so far as that chase is concerned, just as M. de Glehn did when he pointed out that compounding enabled far smaller and lighter locomotives to do the same work that was performed by larger and heavier engines. And the practical results, tested by lengthened experience, do certainly appear conclusively to support these views.

Locomotive Compounding in Britain.

The London and North Western has now been removed from the list of railways that build compound express engines. Mr. George Whale, the new Chief Mechanical Engineer of the premier British railway, has just brought out a fresh type of express locomotive, which, unlike all the express engines which have, nominally, at any rate, been constructed since 1882, that is to say, during the past twenty-two years, is of the non-compound order. Mr. Whale's engine, which is numbered 513, and suggestively named "Precursor," is in many respects an enlargement of the very efficient non-compound express type in the "Precedent" class, which Mr. Webb developed from his predecessor's "Newton" class of 1866, and into which he subsequently converted all the "Newton" set of 96 in number. Those added to the 70 built originally by Mr. Webb himself made a total of 166 locomotives all similar, and to these may be added 90 more, which virtually differ only in having coupled wheels 6 in. smaller in diameter. Latterly, Mr. Webb fitted 3-in. tyres to the 6 ft. 6 in. coupled wheels, thus enlarging their diameter to 6 ft. 9 in. This latter size has been adhered to by Mr. Whale, who, however, has brought his engine up to date by providing far larger boilers and cylinders than any previously in use on the London and North Western. The boiler, which is 11 ft. 9¾ in. long and 5 ft. 2 in. in diameter outside, with a firebox 7 ft. 4 in. in length, yields 2,009 square feet of total heating surface, 161 square feet being in the firebox, which has a grate area of 22·4 square feet. The cylinders placed inside are 19 in. in diameter, or 1 in. more than any non-compound cylinders previously used on the London and North Western. The piston stroke, too, is lengthened from 24 in.—the standard London and North Western length hitherto from time immemorial—to 26 in., the normal modern length of stroke. In respect of steam pressure, Mr. Whale has preferred to make a change in the opposite direction. Mr. Webb had adopted 200 lb. in all his later engines, but this did not always prove satisfactory, and a reduction to 175 lb.—which pressure Mr. Webb was the first English engineer to employ, in 1884—was made in several instances, at all events. Mr. Whale sticks to 175 lb. He retains, however, the "double radial truck"—which his predecessor introduced, and never permitted without protest to be called a bogie—under the leading end of his new engine, contending, as did Mr. Webb in one of his last letters to me, that this plan permits an easier passing of curves than can be secured with the ordinary pivoted bogie. No. 513 "Precursor" is a very handsome locomotive, and, I hear, is already doing good work.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel Mining and Allied Industries.

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OUR MONTHLY SUMMARY.

LONDON, April 22nd, 1904.

Forthcoming Imperial Exhibition.

In May, next year, an Imperial Exhibition will be opened at the Crystal Palace, in which all the governments and administrations of the British Empire will be asked to participate. The object of the exhibition is to "demonstrate that the British Empire produces all the necessaries and luxuries of life in quantities large enough to supply the wants of all its inhabitants, while their quality is at least equal to those produced in any other portion of the globe." In a word, it is intended to prove that the Empire "can be entirely self-sustained, and that in this respect it differs from any other, however large may be its area and varied its resources."

Electrification of Tyneside Lines.

The friendly competition between the North-Eastern and the Lancashire and Yorkshire Railway to be the first to complete the electrification of a standard railway ended practically in a dead-heat. The first electrical train on the newly electrified Tyneside lines of the former company was started by Lord Ridley, and completed the run to Benton and back easily within the scheduled time. At the ensuing luncheon, the British Thomson Houston Company were heartily congratulated upon the successful execution of the work. The average speed of the stopping trains on these lines will be about 22 miles per hour, but between Newcastle and Tynemouth quick trains will be run through without intermediate stops, performing the journey of about eight miles in 15 minutes. The goods traffic will continue to be dealt with, as at present, by steam locomotives, except on the short Quayside branch, on which electrical locomotives of an exceptionally powerful type will be employed. At present, however, only the section from Newcastle to Benton is running electrically, the journey occupying eleven minutes.

The Recovery of Submarine A1.

As we go to press, it is with melancholy interest that we are able to record the end of the long struggle involved in the raising of the unfortunate submarine *A*1. The efforts made to recover the submerged boat have been probably little short of superhuman, and the grit and determination with which it has been accomplished in the face of enormous difficulties should serve to disarm the most unreasonable of critics.

On the subject of the unfortunate submarine, several interesting Parliamentary questions have been asked and answered. Mr. Yerburgh asked whether submarine vessels belonging to His Majesty's Fleet were so fitted that they might be easily grappled and raised in the event of their being so injured that the crew were unable to bring their vessel to the surface, whether *A*1 Submarine could have been raised to the surface within forty-eight hours in the event of her crew having survived the shock of collision, and whether His Majesty's Fleet possessed any special salvage vessels or apparatus for the speedy recovery of vessels sunk in a harbour fairway during war time, or whether

they were entirely dependent upon private firms for such work. Mr. Pretyman's reply is that no special means are provided; these vessels are easily grappled owing to their shape. In the case of the *A1*, no difficulty was experienced in passing hawsers under the vessel and attaching to lighters, and this was done by the dockyard; but, through the sand of the sea, the hawsers parted, and the Commander-in-Chief then reported that there was no alternative but regular salvage operations. With regard to the second part of the question, it is impossible to say; the crew of the *A1* were probably drowned at once. The Admiralty have no special salvage vessels, and are dependent on private firms for such work. At each dockyard port, however, there are very experienced divers and a number of craft that could be utilised for raising vessels.

Mr. Gibson Bowles wished to know whether the Admiralty were aware that there were in existence British salvage companies of great experience and proved ability, and could he explain why none of these companies was called upon to undertake the raising of the sunken submarine *A1*, and why the work was committed to the Swedish Neptune Salvage Company of Stockholm without any opportunity being afforded to any British company to undertake it. In reply to this, Mr. Pretyman states that the Admiralty is aware of the existence of qualified British salvage companies, and has already made use of their services. But the Neptune Salvage Company were successful in raising H.M.S. *Howe* in 1893, and, having one of their ships (the *Belos*) at Portsmouth at the time of the recent accident, their offer was accepted by the Commander-in-Chief, so as not to lose valuable time.

Technical Education in England, America, and Germany.

In the course of a general comparison between technical education in England on the one hand, and Germany and America on the other, Mr. R. Blair expresses the opinion that our evening schools on which we rely for technical instruction, are without parallel anywhere, but he points out that these are mainly training schools for operatives, for the 'hands' rather than for the 'heads.' We have nothing at present equal to the German 'Charlottenburgs' or American 'institutes of technology' for the industrial training of the 'heads,' the future captains of industry. In America such institutions as Sibley College (Cornell University) and the Massachusetts Institutes of Technology are already known throughout the United States and in Europe as institutions of the first rank for the training of 'heads' of industry. Between these and evening schools come others, splendidly equipped and lavishly financed, such as the Pratt Institute, Brooklyn (New York), the Drexel Institute at Philadelphia, or the Lewis Institute at Chicago, which train the 'petty officers,' men to hold intermediate positions between the heads of industries and the skilled mechanics. It is clear that, although in London, Manchester, and elsewhere we have institutions quite as well equipped and capable of giving as good a training as those of America, we have much to learn in the organisation and diffusion of our technical instruction.

Utility of the Mosely Report.

It must not be overlooked that the conditions which obtain here and in the United States are fundamentally different. But while we cannot change the conditions it is nevertheless possible to carefully review the concentrated information which Mr. Mosely's Commission has rendered available, and apply to our own methods features judged worthy of emulation in connection with such points as their freedom from competitive examination, the obligatory participation of technical instructors in practical work, the need at home for increased encouragement on the part of the employers, etc. These and many other useful subjects for reflection will present themselves to readers of the Commission's report which is a volume of some four hundred pages, and can be obtained by anyone for 1s. Moreover, Mr. Mosely, following up the liberality which organised and financed the Commission, has arranged that any educational authority or member thereof in the British Isles, or any county councillor, local manager, headmaster, headmistress, or registered teacher shall obtain copies free on remitting to the publishers the cost of postage. Not only technical men, but all who are interested in education generally can scarcely fail to appreciate very highly the public spirit which Mr. Mosely has displayed and the well-timed service which he has rendered to the cause of educational progress.

Admiral Makaroff.

Russia, by the death of Admiral Makaroff, has lost not only her most able naval commander, but a distinguished scientist and inventor. In 1885 he made a cruise round the world as commander of the frigate *Prince Pojarsky*, and conducted important hydrographic researches which received the award of a prize from the St. Petersburg Academy of Sciences. As Chief Inspector of Artillery—a post which he occupied between 1891 and 1898—Admiral Makaroff designed and introduced several improvements in quick-firing guns. During the construction of the famous ice-breaker *Ermak*, which was built for the Russian Government by Messrs. Armstrong, Whitworth and Co., to his designs, he visited England, and succeeded in making many friends, being especially popular among the workmen.

The Electrical Engineers' Secretaryship.

We are pleased to have an opportunity of congratulating Mr. George C. Lloyd upon his appointment as Secretary of the Institute of Electrical Engineers, for we have more than once had occasion to appreciate his courtesy and tact as Assistant to the Iron and Steel Institute. These qualities contribute largely to the making of a successful secretary, but for the important duties he will be called upon to undertake many others are required, including technical knowledge, and the mastery of detail. Mr. Lloyd gained his education both in this country and in Germany. Upon completing a five years' apprenticeship with Messrs. Robert Stephenson and Company, marine and locomotive engineers of Newcastle-on-Tyne, he went to sea, and was for some years engaged as a marine engineer on English steamers trading with Brazil and the River Plate, and as engineer in Spanish ships trading with the West Indies. On his marriage, however, Mr. Lloyd wisely abandoned the sea, and took up engineering work in London. For a time he also travelled on the Continent as representative of Messrs. Mirrlees-Watson and Co., Limited, of Glasgow, and, prior to his appointment as Assistant to Mr. Bennett H. Brough, Secretary of the Iron and Steel Institute, he was engaged as assistant engineer to the firm of Messrs. Jeremiah Head and Son, of Westminster. As might be expected, he is a good linguist. The post of Assistant Secretary will be filled by Mr. Percy F. Rowell, who was chief assistant to the late Mr. W. G. McMillan.

The British Inventor and his Grievances.

Mr. W. Friese-Greene was one of the first to send in his views on the above question to the *Journal of the Society of Arts*, in response to the complaint raised in that publication by an inventor. He pleads for justice and common-sense in our patent laws, and that it may be made possible not only for a rich inventor to protect himself, but also that a poor inventor may be encouraged to patent his ideas with a certainty that he will obtain a proper return for any good invention he may make, and full protection of his rights without danger of being financially ruined by his own inventive genius and his attempt to contribute something to the welfare of his country. Mr. Friese-Greene's suggestions for the improvement of the patent laws are as follows:—

1. That a thorough search be made by the British Patent Office before the patent is granted.

2. That the cost of this search should be included in the initial fee.

3. That when a patent is once issued by the English Patent Office the presumption is not that it is bad, but that it is good, and that this presumption be one that the British courts are instructed to recognise in any action for infringement.

4. That the penalty for infringement (where the infringement is clearly proved) be not merely an injunction against further infringement and the actual damages proved (which latter are almost impossible of proof in many cases), but should be substantial and exemplary damages, which shall be sufficiently large to discourage others from attempting to infringe what they know to be a valid British patent. In other words, says Mr. Friese-Greene, "make the punishment fit the crime" which is not the case under the present law. In fact, it not infrequently happens that an inventor may win his action for infringemen and be ruined by the delay and expenses he has to ncur over and above his damages and taxed costs.

5. Any man stating in his application that he is the original inventor, when it is proved he knows he is not, should be held to be guilty of perjury and should be prosecuted by the Public Prosecutor at the public expense.

6. Make one fee cover the entire cost of the invention for the full term. Anyone can figure out for himself what it means to maintain 25 or 30 British patents, many of which, while they are the basis of very valuable inventions, may be premature, in that certain features of the invention are not yet perfected, or the trade not yet sufficiently advanced to appreciate its value.

7. The appointment of a Royal Commission consisting of practical men who shall take evidence on the whole subject and report their recommendations to Parliament.

The Tramways and Light Railways Association.

At the annual dinner of the Tramways and Light Railways' Association, Mr. Alfred Baker presided over an attendance of one hundred and twenty. Mr. G. G. Gomme, in proposing the toast of the evening—"The Tramways and Light Railways' Association"—said that the Association had, at all events, solved one very difficult problem. He (Mr. Gomme) could remember the time when light railways were scarcely looked upon as kindred associations to tramways, and he was delighted to find that now they were considered as twins, and the fact that they were now united together in one Association, seemed to him a happy augury for the future. They, in London, were face to face with many difficulties, and they could not help feeling that an Association of this kind would help them to meet many of those difficulties—he meant, the difficulties of overcoming space, which could only be done by tramways and light railways. Mr. Atherley Jones, K.C., M.P., responded. After congratulating the members on the accession to office of Mr. Baker as President, he remarked that the object of the Association was to develop, as far as possible, by co-operation with kindred associations, and by legislative action, the interests of the public in the promotion of cheap and facile locomotion. He did not know that it had done very much towards the attainment of that result, but that had not been through any want of effort on the part of the Association, but through the innate conservatism that was the characteristic of English people. No one could deny that the present system of locomotion in this country was in a chaotic condition, and they believed that those difficulties could be best removed by those representing the various interests meeting together for the purpose of seeing where friction existed, and how it could best be removed. He believed there were representatives of railways there that evening, and he knew that not so very long ago the railways regarded tramways and light railways as dangerous rivals and as competing bodies. He did not believe that was the right view, but that tramways and light railways performed a work which was auxiliary and contributary to the advancement of railway communication in this country. In the same way, he believed that even the proprietors of omnibuses might be induced to regard the transition of a tramway over Westminster Bridge as not necessarily destructive to the British Constitution. An Association like that which had been able to enlist the co-operation and the sincere and active interest of men like Mr. Baker and others who were present was undoubtedly doing something and would hereafter do more to develop, in the interests of the public, the increased locomotion between various centres of population and also between what they might term the rural suburbs of great cities and the centres of those cities. By that means they would be doing something to solve the problem of the great glut of population in certain districts. The Chairman, during the evening, referred to the fact that he had just had placed in his hands a *souvenir* of the opening of the first tramway laid in London. It was in 1861, and was called the Marble Arch Railway. The guests invited on the occasion by the late lamented Mr. G. Francis Train, numbered several hundreds.

Labour Returns for March.

The Board of Trade labour returns for March show that there was a slight improvement as compared with the preceding month, due in some measure to seasonable causes. There was some improvement in employment for coal miners, and in the iron-mining industry it continues good. In the pig-iron industry employment improved slightly during March, but is still below the e..l of a year ago; while in the iron and steel manufacture employment showed an improvement as compared with a month ago, and is about the same as a year ago. Employment in the shipbuilding trades continued to improve slightly during the month. It is, however, still bad, and worse than a year ago. The percentage of unemployed trade union members at the end of March was 11·8, as compared with 12·6 in February and 9·8 in March, 1903.

NAVAL NOTES.

BY

N. I. D.

GREAT BRITAIN.

SINCE my last instalment of notes, dealing with naval matters the estimates for the year 1904-05 have been published. They amount to £36,889,000, which is more by nearly a million and a half than the sum voted last year. Nearly half this latter sum, however, is required to complete the purchase of the new battleships *Triumph* and *Swiftsure*, and thus the actual increase is not so large as it appears at first sight. The new construction proposed for this year is made up of two battleships of a new type to be called the *Lord Nelson* class, four armoured cruisers of the *Duke of Edinburgh* class, fourteen destroyers, and ten submarines. The battleships will be built by contract, and will be laid down in the autumn.

Next to the publication of the Estimates, perhaps the most important event has been the completion and commissioning of the *Queen* and *Prince of Wales* battleships. The *Prince of Wales* relieves the *Exmouth* in the Mediterranean, in which fleet the *Queen* relieves the *Russell*. Another important commissioning is that of the *Cornwallis* on February 9th for the Mediterranean.

The trials of the *Triumph* and *Swiftsure* have now been carried out, with extremely satisfactory results in both instances. Both vessels succeeded in developing more than the anticipated horse-power, and the speeds attained were 20·17 and 20·5 knots by the *Triumph* and *Swiftsure*, respectively; the i.h.p. in each case was rather more than 14,000, and the coal consumption was 1·73 lb. per unit of power per hour. It is of importance, however, to note that these vessels only underwent six hours full power trials, whereas all other vessels for the Royal Navy undergo eight hours.

Launches have not been very numerous in the armoured cruiser class during the last two months, the *Argyll*, which was launched on March 3rd, by the Greenock Foundry Company being the only one of importance. The *Devonshire* will leave the slips at Chatham before these lines appear, and with her the last of the County cruisers will be in the water.

A change in the armament of the later vessels of the *Duke of Edinburgh* class is to be undertaken. The change will involve structural alterations. The secondary armament of ten 6-in. guns is to be replaced by four 7·5-in. guns. These guns will be placed on the upper deck instead of on the main deck, as the original pieces were. The advantages gained by such a change are obvious, and the reduction in the number of guns is a small disadvantage compared with the increase in weight and command. Changes are also taking place in the *Devonshire* class, where the four forward 6-in. guns will be replaced by two 7·5-in. guns, in gun houses, on the upper deck, again with an increased command and consequently more effective long range fire.

The *Essex* has been put into commission, as has also the *Lancaster*, the latter on March 22nd, and the former on February 5th. There are now seven vessels of the earlier County class in commission, and the *Cornwall*, *Suffolk*, and *Cumberland* should also hoist the pennant before the autumn. The *Cornwall's* trials have been completed with very satisfactory results, the vessel attaining a speed of twenty-four knots on her eight hours full-power trial.

Among smaller craft, there is the launch of the *Sapphire*, third-class cruiser, to chronicle on March 17th, at Palmer's Yard, Jarrow. The *Sapphire* is the last of four vessels named after gems, two more of which were projected in last year's programme, but were ultimately abandoned. The launch of the *Sapphire* took place three months after the first keel plate was laid.

The first of the new "scouts," the *Sentinel*, has been launched by Messrs. Vickers, Sons, and Maxim. The ceremony was performed by Miss Hay, daughter of one of the directors of the company, on April 19th. The *Sentinel* is 360 ft. in length, with 40 ft. beam, and 2,920 tons displacement. Her estimated horse-power is 17,000, and the maximum speed is to be 25 knots, steam being supplied by twelve boilers.

FRANCE.

The launch of the armoured cruiser *Victor Hugo*, at Lorient, on March 30th, has made it at last possible for work to be commenced on the *Jules Michelet*. The *Victor Hugo* was on the stocks thirteen months, some delay in her construction having been occasioned by the transfer to Lorient of building material from the dockyard at Toulon where it was originally intended she should be built.

The *Gloire*, armoured cruiser, has completed her trials. On her full power trial the horse-power developed by her engines was 14,400 giving a speed of 21·5 knots. The coal consumption worked out at 1·96 lb. per i.h.p. per hour. Her sister ship, the *Condé*, on trial attained a speed of 19 knots.

The *Leon Gambetta*, while on a steam trial, struck an unknown pinnacle of rock off the Black Rock Islands, near Brest. The damage done appears to be considerable, and it will be some months before the repairs can be completed.

Some interesting details about the new French torpedo-boats have been made public. The class is numbered 278-292, and the vessels are 121·4 ft. in length. They displace 90·6 tons, and, with engines designed to develop 1,900 h.p., are expected to make 26 knots speed. No. 279, which is already complete, made on her trials 26·55 knots. Two others of different design have just been launched—No. 293 at the Normand Yard, Havre; and No. 294 at Bordeaux. No. 293 is 129 ft. in length, displaces 97 tons, and is fitted with Parsons's turbine engines. Three turbines will be used when she is going at full speed (24 knots); one will be used for cruising speeds, and one for going astern. Her boilers will be Normand water-tube. No. 294 will be 126 ft. long, and fitted with turbines of Bréguet design. Her speed will also be 24 knots.

Two submarines are known to have been launched recently, the *Bonite*, at Toulon, on February 6th, and the *Aigrette* at the same port on February 23rd. This latter vessel of 172 tons displacement is one of thirteen which were to have been begun in 1902, but on two only of which work has been commenced.

GERMANY.

A scheme for further naval expansion is brewing in Germany beyond a doubt, and a new Navy Act may very shortly be introduced to the Reichstag. But for the present there is little to report beyond the launch of the small cruiser *Lübeck*, built at the Vulcan Yard, Stettin, and formerly known as the *Ersatz Mercur*. This vessel is chiefly notable for being one of the first German vessels to be fitted with turbines.

The programme for the completion of the battleships of the *Braunschweig* class puts the date of commissioning of the first two, the *Braunschweig* and *Elsass*, in August and October next, respectively. Of cruisers, it is hoped to have the *Hamburg*, *Bremen*,

and *Berlin*, all in commission. The new torpedo-boats *S120-125*, are expected to complete their trials during the year.

There are several vessels which it is hoped will be launched during the year, and two small cruisers, one at Bremen and one at Stettin, will take the water early in 1905. In the meantime, the armoured cruiser *Prinz Friedrich Karl* has commenced her trials at Wilhelmshaven. Her first full-speed trial gave very satisfactory results, the contract i.h.p. 17,000 having been easily developed, giving the vessel a speed of 21 knots. The *Elsass* will shortly commence her trials.

RUSSIA.

The new battleship *Imperator Alexander III.* has been under trial, with apparently satisfactory results. The engines, designed by Engineer Tenson, making on an average 114 revolutions under 250 lb. pressure of steam developed, 15,800 h.p. giving a speed of 17·36 knots. The coal consumption worked out approximately at 2·5 lb.

The Russian naval estimates for 1904 total 113,622,426 roubles, nearly three million roubles less than the sum actually expended during 1903. For shipbuilding and repairs the sum of 38,743,446 roubles is appropriated. No particulars of new vessels have, however, been made public, and the only ones which are reported to have been laid down are two protected cruisers in the Black Sea.

It cannot be out of place here to add a word about the catastrophe which occurred at Port Arthur on April 13th. The blowing up of the *Petropavlovsk*, with Vice-Admiral Makaroff on board, is one of those disasters at which all the world, belligerents as well as neutrals, stands aghast. The mines on which the ill-fated vessel struck appear to have been laid during the night by a Japanese mining vessel (Commander Oda) protected by two torpedo flotillas. Although the searchlights from the port were playing on her the whole time, the work she was doing does not appear to have been suspected by the Russians. At dawn on the 13th, two torpedo actions took place, and, as a consequence, one Russian destroyer, the *Bestrashni*, was sunk. At about 8 a.m., Admiral Makaroff, with all his available ships, set out in pursuit of the Japanese third squadron, consisting of the protected cruisers *Chitose*, *Yoshino*, *Kasagi*, and *Takasago*, under the command of Rear-Admiral Dewa. This squadron, by gradually retiring drew the Russian fleet further and further from its port. Admiral Togo, when informed by wireless telegraphy, of the success of his junior's ruse, made a dash for the harbour entrance. Vice-Admiral Makaroff appears, however, to have discovered the trap and made for port. On the way the *Petropavlovsk* encountered the mines, which sent her to the bottom, and the *Pobieda* was also reported to have been damaged. The Russian fleet in the Far East is now a negligible factor. Admiral Alexeieff is reported to have received stringent orders to keep his ships in the harbour until Vice-Admiral Skrydloff, who succeeds Makaroff, arrives. But before then Togo is almost certain to have made another, and very possibly successful effort to close the entrance to the harbour.

The Russians are shortly to have some submarines at Port Arthur, one having been already dispatched in sections, and the other being nearly completed.

UNITED STATES.

The Naval Appropriation Bill, which was accepted by the Senate on February 11th, includes, as new construction, one battleship of 16,000 tons, two armoured cruisers, of 14,500 tons; and three scouts, of 3,750 tons. These scouts it is reported are to have a speed of 24 knots and will have a radius of action of 5,000 miles. The protection will be slight and the guns of 3·9-in. calibre. The total amount authorised is $96,338,038, of which $29,885,000 will be devoted to the new programme.

The hull contracts for both the *Idaho* and *Mississippi* have been awarded to the Cramp Company of Philadelphia. Each is estimated at £600,000.

The *Virginia*, battleship, was launched on April 5th from the yards of the Newport News Company. The battleship *Rhode Island* and the armoured cruiser *California* should also be in the water before these lines appear.

Progress on the vessels in hand at the various yards is favourably reported on.

JAPAN.

The most interesting item of news concerning the Japanese Navy is the description which has been made public of the new battleship design. One vessel of this class is building at Elswick, and another at Barrow. These vessels are to be completed in twenty-nine months. The principal dimensions are: length, 455 ft.; breadth, 78 ft. 2 in.; draught, 26 ft. 7½ in. The displacement is 16,400 tons, and the speed at least 18½ knots. The horse-power, curiously enough, is not mentioned. The boilers, twenty in number, will be of the Niclausse type disposed in three boiler rooms, and will be built, with the main propelling machinery, by Messrs. Humphreys, Tennant and Co. The armament will consist of four 12-in. guns, mounted in pairs in barbettes, fore and aft; four 10-in. guns mounted singly in barbettes; twelve 6-in. guns disposed six on each broadside, five in the citadel and one on the upper deck; twelve 12-pounders and three 3-pounders. In addition, there will be five torpedo-tubes, four of them of the ordinary Armstrong-Whitworth 18-in. type and one on the line of keel astern, of a special design.

With regard to the armour protection there seems to be a tendency to revert to the box battery arrangement of the early seventies of the last century. The armour amidships is carried from below the water-lines right up to the upper deck. The main armour belt has a maximum thickness of 9 in., and extends from 5 ft. below to 2 ft. 6 in. above the water-line, and immediately above this again is a belt of 6-in. armour, extending from the after, 12-in. barbette, forward to the stem. Above this again is the 6-in. citadel armour, carried to the height of the upper deck, and enclosing both 12-in. barbettes. The barbette armour of the 12-in. guns is 9 in. thick on the exposed portions and 5 in. where the citadel encloses them. The 10-in. barbettes have 6-in. armour while the conning tower has 9 in., and the observer tower 5 in. of protection. In addition to these shelters for the officers there are three others, protected by 3-in. armour one above the conning tower, and one on each side of it. The protective deck which runs throughout the entire length of the vessel protecting the machinery, magazines, etc., is 2 in. thick on the flat portions amidships and 3 in. on the sloping sides which are carried down to meet the bottom of the main armour belt.

It is reported, and with some show of authority, that the Japanese have bought two submarines of Holland design, and that these vessels are now on passage to Yokohama.

Widening London Bridge.

Since the last issue of this magazine went to press, the widened footways of London Bridge have been formally opened by the Lord Mayor. The work was begun in 1902, the roadway at that time being 34 ft. 6 in. in width, and the two footways 9 ft. 6 in. each, a total of 53 ft. 6 in. between parapets. After the widening, the roadway is 35 ft., and the two footways 15 ft. each, the total width between parapets now being 65 ft. The approximate amount of old granite removed for the recent widening was 55,000 cubic feet, the amount of new granite fixed being about 51,000 ft. The widening is carried on 325 granite-corbels fixed on each side of the bridge, each corbel being 10 ft. long by 1 ft. 5 in. average width by 3 ft. 3 in. deep, and anchored down to the bridge by two bolts 1½ in. in diameter. The parapets are 3 ft. 6 in. high, there being 1,452 balusters in the parapets. The amount of the contract was £95,484 exclusive of the lamps and lamp standards, and the work was completed within the contract time of two years. Mr. A. Murray, F.R.I.B.A., was the architect, Mr. E. Cruttwell, M.Inst.C.E., being the engineer, and Messrs. Pethick Bros. the contractors.

The Proposed New Humber Dock.

According to Sir John Wolfe Barry's evidence before the Parliamentary Committee which has had under consideration the Bill promoted by the Humber Commercial Railway and Dock Company, the proposed new dock on the Humber at Immingham, near Grimsby, should be the finest on the East Coast. The scheme provides for main dock with a deep-water area of 38½ acres, the arms being 1,250 ft. long and 375 ft. wide. Three other arms could be made, and, in this event, the total deep-water area of the dock would be 71 acres. There would be at first 4,800 lineal feet of quay space, and when all the arms were finished, 12,300 lineal feet. The lock is proposed to be 750 ft. long and 85 ft. wide, with a depth of water on the sill of 47 ft. 6 in. at high-water of spring tides and 43 ft. 6 in. at high-water of neap tides, and 28 ft. at low-water of spring tides. The entrance channel is designed to have 29 ft. at low-water of spring tides. This would admit of the largest steamers entering the dock at any state of the tide. The Great Central Railway Company are co-operating in the promotion of the scheme, which involves the connection of their main line with the dock by a short railway. The estimated cost of the works is set down at £1,102,565, this including £75,710 for the connecting railway.

The Mono-Rail System.

One of the most notable English exhibits at the St. Louis Exhibition will be a working model of the Behr Mono-rail system. The model, which has been on exhibition in London, is built on a scale of ¾ in. to the foot, and comprises a circular track with motor-car. Embodied in this working model are a number of improvements which were recently described by the inventor at a meeting of the London Chamber of Commerce. In the course of his remarks, Mr. Behr pointed out that speeds were to be increased and express passenger trains multiplied, new rails must be laid to accommodate express traffic solely, and if these new lines were constructed on the mono-rail system, to follow the present rails and run into the same stations, a most beneficial effect would be produced on the receipts of the existing companies. They would be able to inaugurate a passenger service with at least double the speed of the fastest express trains, and by using their existing rails for local passenger and goods traffic only, they would evolve order out of chaos and punctuality out of an ever-increasing unpunctuality, would eliminate 99 per cent. of all the accidents that now occurred, and would effect a reduction in the costs of working and maintenance, which would enable them to increase their dividends while diminishing their charges.

Lowering the Sill of the Ramsden Dock at Barrow.

An interesting description of this work was given at a recent meeting of the Institution of Civil Engineers, by Mr. L. H. Savile, A.M.Inst.C.E. The contract for the work was let on June 8th, 1899, to Messrs. John Aird and Co., Mr. Frank Stileman being Chief Engineer. Besides the lowering of No. 4 sill, of Ramsden Dock by 6 ft., a quay wall, 900 ft. long, on the south side of the basin, and another, 500 ft. long, on the north side, had to be constructed. The contract was let on the understanding that these quay-walls were to be completed before the lock was closed for the lowering of the sill. The main object with which the work was undertaken was to allow large battleships being built by Messrs. Vickers, Sons, and Maxim to have access to the docks, as there was only 24 ft. of water on the existing sill, and the battleship then being built for the Japanese Navy, had a draft of 27 ft. 3 in.

On the completion of the quay-walls, cofferdams were built across the ends of the Ramsden Dock lock, and the water was pumped out, so that the work on the sill might be done in the dry. The operations involved in this work were: Removing the old gates; cutting away the old gate-floor; rebuilding the floor 6 ft. lower, so as to take a sliding caisson in place of gates; building a caisson-recess; and providing and installing a sliding caisson.

Special Difficulties Overcome.

Shortly after the lock had been pumped dry and the removal of the sill begun, an accident occurred through the water breaking under the pier-head on the north-east side of the lock, whereby the work was considerably delayed, as the cofferdam at the north end of the lock had to be lengthened before the water could be again pumped out. In consequence of this accident, which damaged the pier-head and showed the unreliability of the bottom, special precautions were taken in carrying out the remainder of the work; these consisted of driving cast-iron sheet piles in front of the old sill, and taking out the old floor in small squares. No further trouble was met with, and the new sill was completed on April 21st, 1901. The pier-head, which had been damaged by the water breaking through, was moved, and a timber head was built in its place. The cofferdams were now removed, the sliding caisson was launched and floated into the recess prepared for it on the west side of the lock, and the lock was re-opened for traffic on May 17th, 1901. The sliding caisson, which takes the place of the old gates, was designed to take a head of water on either side, thus doing the duty of two pairs of gates; it also serves as a roadway, 12 ft. wide, across the lock, for heavy vehicular traffic. The caisson is tank-shaped, 103 ft. long, 12 ft. wide, and 39 ft. 6 in. deep. It has four watertight compartments so arranged that the caisson does not quite float, thereby reducing to a minimum the friction when the caisson is being drawn across the lock. Hydraulic machinery is used for hauling the caisson to and fro, and also for working the sluices in the caisson.

ELECTRICAL AFFAIRS.

BY

E. KILBURN SCOTT, M.I.E.E., A.M.Inst.C.E.

Electric Lighting of the City of Westminster.

Mr. J. W. Bradley, the City Engineer to Westminster, is doing the electrical profession a great service by issuing quarterly reports on Street Lighting by gas and by electricity. The table below gives the statement of comparative costs extending over a period of eighteen months, and it will be seen that the lowest total cost per candle-power per annum is 8·7d. for electric arcs supplied with current by the Westminster Electric Supply Corporation. The average of all the electric lighting is 11·7d., whereas the average of the gas lighting is over 25d., and if after all these years gas cannot do better than the figures tabulated by Mr. Bradley it is a bad look-out for its future as a street illuminant:—

TESTS OF STREET LAMPS IN CITY OF WESTMINSTER, WITH STATEMENT OF COSTS EXTENDING OVER A PERIOD OF 18 MONTHS.

Description and Position of Lamps.	No. of Lamps in City, of Class specified.	Average Candle Power.	Total Cost per Lamp per annum.	Total Cost per Candle Power per hour.	Test No. 6. Total Cost per Candle Power per annum.	Average Total Cost per Candle Power per annum, including all tests up to date. (6 Series).	Total No. of Tests up to date.
			£ s. d.	d.	d.	d.	
Electric arcs (Charing Cross and Strand Electric Light Company), opalescent globes	100	**670**	30 0 0	·00273	10·75	**11·49**	40
Electric arcs (St. James's and Pall Mall Electric Light Company), Muranese globes	60	**474**	34 0 0	·00445	17·23	**15·1**	43
Electric arcs (Westminster Electric Supply Corporation), opalescent globes	945	**605**	22 0 0	·00222	8·73	**8·7**	35
Refuge lanterns, four mantles, Victoria Street	12	**113**	13 6 6	·0072	28·3	**30·7***	24
Sugg's high-pressure lamps, Parliament Street	29	**573**	18 5 0	·00194	7·65	**9·85**	35
Incandescent mantles, Victoria Street type	1,241	**42**	3 10 0	·00508	20·0	**18·42**	40
Triple flat flame, footway, Whitehall, now in process of removal, Scott-Snell lamps being substituted	35	**51**	6 1 2	·0076	29·9	**25·65**	33
Incandescent mantles, Carlton House Terrace type	251	**38**	2 17 11	·00465	18·3	**18·18***	27
Triple flat flame, Strand type ...	508	**47**	9 8 10	·0122	48·2	**47·44***	30

* Average of five series only.

Testing of Gas and Electric Light.

In making such tests as these the Sugg photometer is employed, and it is fitted with two and five candle standards for testing both low and high-power lamps. From its construction it gives results in all cases if anything slightly higher than the true values, but the error is constant, so that the comparison is correct. Precautions are necessary to guard against extraneous light reflection from buildings, obstruction by opaque objects, etc., and the readings must be taken on a clear night. In the case of incandescent mantles great variation in candle-power results from quite a *slight defect in the mantle*, and this is particularly the case with high-pressure lamps. This circumstance renders it difficult to form any comparison between tests carried out in a laboratory and those made under actual lighting conditions. Groups of incandescent mantles in particular are difficult to keep in order, and in a lantern the effective candle power does not by any means increase in the same ratio as the number of mantles.

Soldering Joints in Bulk.

Soldering by hand with an iron is one of those finicking things which should be banished from an electrical engineer's works as soon as possible. If solder must be used, it might just as well be done wholesale by first dipping the parts into flux and then into melted solder. With a little special design the joints between armature coils and commutator segments could be done in this way, and it has already been in vogue for some time on the Continent for soldering the conductors of short circuited rotors to the end rings.

Where joints are not suitable for soldering in this way there is no reason why, with a little scheming, such joints should not be mechanical. In many of the largest German-made dynamos the armature conductors are fastened to the commutator segments by several ¼-in. steel grub screws.

POWER STATION NOTES.

BY E. K. S.

Scale in Boilers.

It is generally supposed that scale in a boiler materially reduces the steam-raising efficiency by cutting down the heat transmission from the gases to the water, but, as a matter of fact, this heat transmission is seldom reduced more than ten per cent. The principal objection to scale lies in the fact that it seriously increases the wear and tear and endangers the safety of the boilers. In clean boilers the temperature of the furnace plate is nearly the same as that of the water, whereas in a scaly boiler the excess temperature may be about one-tenth of that of the flame; in other words, the temperature of the furnace plate may be raised by say 300 deg. F. In the first case when the furnace door is opened and cold air admitted the contraction of the furnace plate will be quite inappreciable. In a scaly boiler, on the other hand, the rapid reduction of 300 deg. F. means a contraction of nearly a quarter of an inch in a length of 10 ft. This is capable of setting up a stress of over 20 tons to the square inch and the constant straining due to the furnace door being opened and closed will, in due time, groove the furnace flanges.

Importance of a Roughened Surface in Boilers.

Those who have seen the old type Lancashire boilers under construction will have noticed that before the plates go to the marking-off table the surface is treated with a kind of chalky paint. At first sight it may seem that this is put on simply to throw up the scribing marks of the rivet holes, etc. There is, however, another purpose, and that is to roughen the surface so that the water will boil off it more readily. Rough points are necessary to give a nucleus for the small steam bubbles to rise from, for when water lies in contact with smooth metal it boils explosively. This effect may be noticed when boiling water in a glass test tube, a few grains of sand or other material immediately quietens the boiling.

The point to specially note in regard to this fact is, that whereas plates are easily treated to give this roughened surface, small diameter boiler tubes are not. It is just possible that various minor troubles with water-tube boilers are traceable to this fact.

Utilisation of Waste Material in Collieries.

There is an old proverb that "the cobbler's children are always the worst shod," and this would appear to apply to collieries, because there are probably no more wasteful engines in the world than those ordinarily used in collieries. A consumption of 4 lb. to 12 lb. of coal per horse-power per hour is quite common, and the boilers more often work at under 50 lb. per square inch than over. There are, of course, distinguished exceptions, because with the introduction of electrical plant many collieries are being brought up-to-date.

One direction in which colliery engineers might save a good deal is in burning the black coaly "bands," and small coal which is now thrown into the goaf as rubbish. By breaking up the "band" into small pieces in a stone-breaker and mechanically stoking it under forced draught, such material would give off a considerable amount of heat. Its utilisation in this way would not only be a saving, but would also reduce the chance of fire in the goaf.

We are asked to state that the type of Underfeed Stoker with steam-driven ram referred to last month in Power Station Notes, is made by Erith's Engineering Company, of 70, Gracechurch Street, E.C.—ED.

Improvements in Gas Producing.

Amongst recent improvements in gas producers may be mentioned that embodied in the Whitfield producer. In an ordinary producer air is usually injected by means of a steam-jet blower into the space below the inclined grate, and the gases produced by the passage of the air and steam through the fuel are drawn off from the top of the producer, along with the light hydrocarbons distilled from the coal.

Gas produced in this way is certainly large in quantity, but its calorific value is rather low, and it is, moreover, liable to be contaminated with tar vapour, which, if not carefully removed by subsequent washing, is liable to give trouble by depositing tar on any cool surface with which it comes in contact. If used for power purposes, this deposit may be on the engine valves, and it may seriously interfere with the proper working of the same. Such tar deposits, also, of course, represent loss of calorific value.

The characteristic feature of the Whitfield producer is the method of dealing with the volatile portion of the coal, namely, the hydrocarbons or tar vapours. Unlike most other producers the outlet is not at the top of the producer above the level of the fuel, but is at one side and below the surface of the bed of the fuel. The easily-volatilised hydrocarbons, driven off from the upper surface of the fuel, are collected by a steam injecting arrangement and forced into the incandescent fuel near the bottom of the producer, but above the zone of combustion. Here the steam in the jet is dissociated, the oxygen combining with the carbon of the hydrocarbons to form carbon monoxide, and passing away through the outlet to the gasometer.

It is important to notice that no air is admitted to the circulating pipe, the sole object of the latter being to draw off the volatile hydrocarbons and tar vapours evolved from the upper layers of fuel. By combining them with steam they are converted into carbon monoxide and hydrogen free from any diluent.

It may be mentioned that Messrs. W. F. Mason, of Manchester, are laying down these producers at the following places:—

Reading, 1,800 h.p. for Willans' gas engines; McMurray's Paper Mills, 800 h.p. for Willans' gas engines; Clement Talbot Automobile Works, 600 h.p. for Westinghouse gas engines.

The Use of Illuminating Gas for Engines.

The success of large engines working with poor gases, such as those from blast furnaces, has drawn attention to the fact that, generally speaking, illuminating gas is far too explosive. By burning slowly, poor gases do not bring such great stresses to bear on the fixed and moving parts, indeed, a blast furnace gas-engine works comparatively quietly.

The trouble with illuminating gas is due to the hydrogen present, and it might be worth while the gas companies considering how they can de-hydrogenise their gas for purposes of power. The writer assumes, of course, that they are anxious to increase their connection amongst power users. It is rather surprising that they have not hitherto investigated the matter; possibly it may be due to the fact that when gas-works are taken over by a municipality, an energetic, pushing management generally gives place to a sleepy irresponsible one.

IRON AND STEEL NOTES.

By E. H. B.

The Iron and Steel Institute.

The annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers on the 5th and 6th of May. The following is a list of Papers expected to be submitted :—" On Pyrometers suitable for Metallurgical Works " (Report of Committee).—" On Coke Ovens," by C. Lowthian Bell (Middlesbrough).—" On Troostite," by H. C. Boynton (Harvard University).—" On the Range of Solidification and the Critical Ranges of Iron-Carbon Alloys," by H. C. H. Carpenter, M.A., Ph.D., and B. F. E. Keeling, B.A. (National Physical Laboratory).—" On Explosions produced by Ferrosilicon," by A. Dupré, Ph.D., Chemical Adviser to the Explosives Department, Home Office ; and Captain M. B. Lloyd, R.A., H.M. Inspector of Explosives.—" On the Thermal Efficiency of the Blast-Furnace," by W. J. Foster (Darlaston).—" On the Production and Thermal Treatment of Steel in Large Masses," by Cosmo Johns (Sheffield).—" On the Manufacture of Pig-Iron from Briquettes at Herräng, Sweden," by Professor H. Louis, M.A., Assoc.R.S.M. (Newcastle-on-Tyne). Reports on research work carried out during the past year will be submitted by C. O. Bannister (London), by P. Breuil (Paris), by K. A. Gunnar Dillner and A. F. Enström (Stockholm), by J. C. Gardner (Middlesbrough), by F. H. Wigham (Wakefield), by A. Campion (Cooper's Hill), and by P. Longmuir (Sheffield), Andrew Carnegie Research Scholars.

The Microscopic Analysis of Metals.

What should prove to be a standard work on the Microscopic Analysis of Metals, has been issued by Messrs. Charles Griffin and Company, Ltd., being an English translation of two papers by Mons. Floris Osmond, of Paris. The illustrations alone, covering a wide range of micro-photographs, render the work a most desirable addition to the reference library, and of the matter, it is only necessary to say that it is edited by that well-known authority on this side of the channel, Mr. J. E. Stead, F.R.S., F.I.C. The opening paper on " Metallography considered as a Method of Assay," was read before the International Association for the Testing of Materials in 1897 at the Stockholm Congress, and forms a suitable introduction to the second part on " The Micrographic Analysis of Carbon Steels." At the same time the author has added a chapter describing the micro and photographic apparatus employed, together with an appendix on Austenite. Of Mons. Osmond's work, Mr. Stead says : " Its unique value is due to the great accuracy of the author's experimental observations. The careful and logical reasoning and hypothetical conclusions arrived at have their charm, and none can carefully read them without feeling that they have been made by a master mind, whose one aim is to arrive at the truth." I may add that the descriptions are most clear, more especially that which concerns the author's method of fine polishing. This involves three successive operations, viz. : polishing in bas-relief, " polish-attack," and the action of suitable chemical reagents.

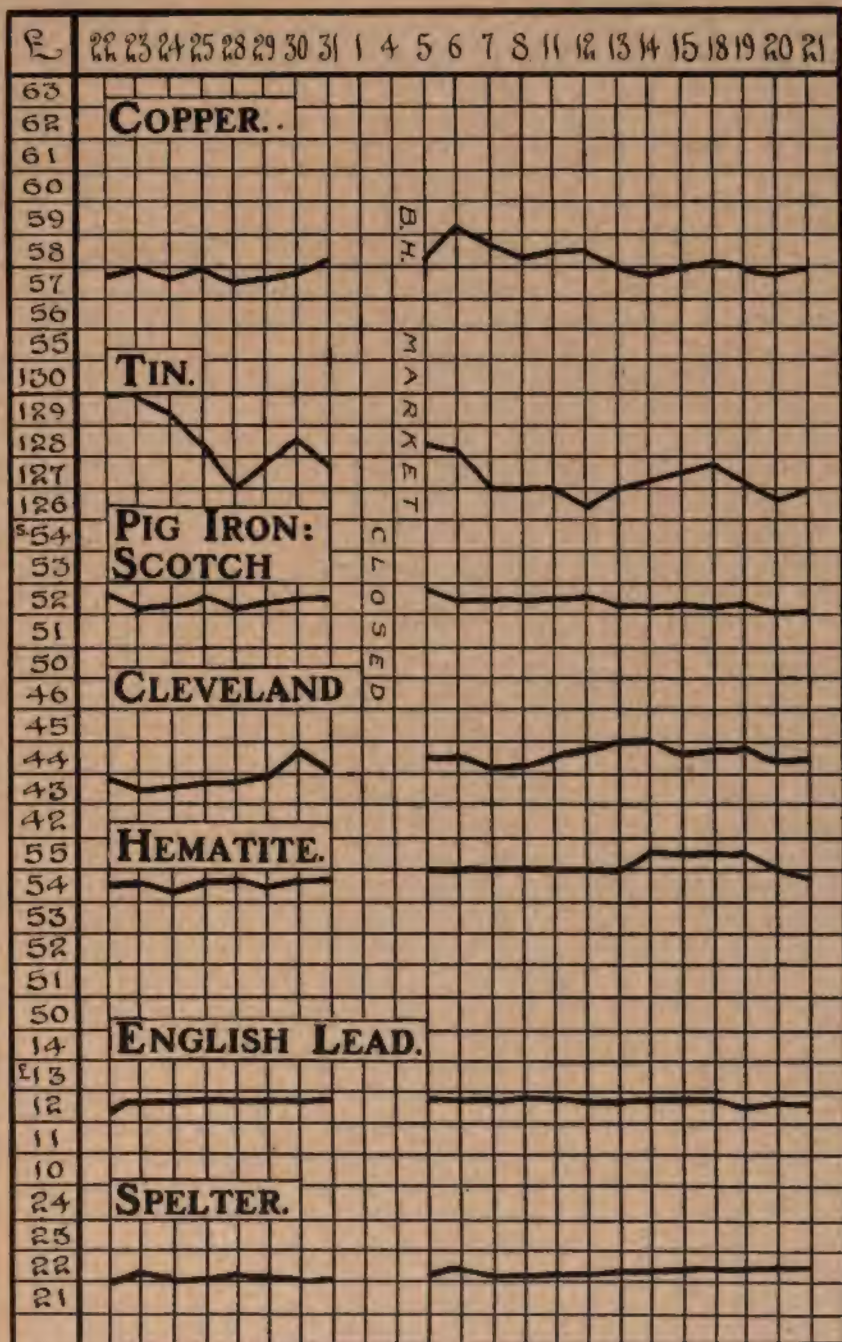
Formation of the German Steel Trust.

The German steel syndicate has at length been organised by twenty-eight of the largest concerns in the country, the smaller manufacturers, whose output ranges from 1,000,000 to 1,500,000 tons annually, being excluded. Twenty companies began the final movement, and reinforced their case with threats of ruinous competition against the independents, which they would keep up until they had driven them out of the markets of the world. These threats had the desired result, except in the cases of the Phœnix Steel Works and the Westfälische Steel Works. The demands of the Krupp Company, which were considered excessive, presented one of the greatest difficulties to the negotiators of the syndicate. The interested companies, however, reached a compromise with the Krupp Company, the allotment made it on an increasing scale reaching 700,000 tons on April 1st, 1907. It is stated that the head office will probably be either at Cologne or Düsseldorf.

Rail Steel and the Future of the Basic Open-hearth Process.

An interesting paper was that which Mr. Robert W. Hunt of Chicago contributed at the annual meeting of the American Institute of Mining Engineers, on Rail Steel. He remarked that, while some of them with experience covering the whole history of the manufacture of steel rails, were aware of the great differences in the conditions governing their production at various periods, he did not think the engineering world generally appreciated the direct and imperative influence those variations had had, and were having, upon the wearing quality of the rails.

In the earlier days the steel was poured into ingots which would make but two 30-ft. rails of not exceeding 60 lb. weight per yard—giving a mass weighing, say, about 1,400 lb., and of a section of about 12 in. square. To-day the ingots were some 22 in. square, and weighed more than 4,000 lb. Of course, the interior of the larger ingots must remain hot and liquid longer than that of the smaller ones, and from this condition arose the steel rail makers' *bete noir*—segregation of the metalloids and piping of the steel. The smallest-



THE HOME METAL MARKET.

Chart showing daily fluctuations between March 22nd and April 21st, 1904.

sectioned ingot would pipe, but with the increase of its size, so would be that of the interior cavity. This tendency existing and being well known, it would seem that rather than being ignored, especial care should be exercised to avoid the evils arising from it.

In the course of his paper, Mr. Hunt expressed his belief that the one question of ore-supply would in time, compel the increased use in that country of the basic open-hearth process. They could not for ever continue the rejection of ores which were in every other quality suitable for steel making, because their phosphorus-content was outside of the Bessemer limit. And if at the same time, by the use of the other process, they produced a better metal, at cost not much if any greater, the outcome was inevitable.

Phosphorus was the controlling element in rail-steel. If that could be practically disregarded, no one would deny the ability to make a better article, no matter for what purpose it might be intended.

So far as rails were concerned, the theory relating to the difference in the wear of the steel made by the two processes was being subjected to the crucial test of practice. But no matter what steel was used, care must be exercised in making it; in pouring the ingots; in their handling and heating; and in the rolling and straightening of the rails.

The Physics of Cast Iron.

According to Mr. Richard Moldenke, of New York the use of aluminium in the foundry is becoming more limited than it was, for the reason that it has been found to be injurious to the harder irons; that is, for hard irons the remarkable property possessed by the light metal of throwing out the graphite militates against its usefulness. For the soft varieties of iron, a small quantity of aluminium, added when gases are feared, s very good, but proper precautions in melting should make the need of this addition unnecessary. On the other hand, the use of titanium-iron alloys is to be commended, because the titanium reacts directly with any oxygen or nitrogen present in solution, and, as a consequence, a purification takes place which cannot be overvalued. Increasing the strength of an iron 20 per cent., without remaining behind as an integral part of the metal, seems to be the function of this new candidate for foundry favours. With regard to the addition of other metals, such as nickel, cobalt, etc., but little is heard about them in the foundry. These metals, or their alloys, are too expensive, and consequently it is more profitable to use steel castings for material of a strength greater than that of cast-iron.

At the conclusion of his remarks on the physics of cast-iron, Mr. Moldenke said the future of their studies seemed to lie in the devising of methods to control the chemical composition of cast-iron in cupola and furnace, irrespective of the nature of the pig and scrap charged. Thus we should be able to eliminate sulphur, and perhaps phosphorus, at will. We should also be able to remove the last traces of oxidation, which had been due either to the blast-furnace or to the cupola-furnace at some previous smelting. With those desiderata the field for the maker of foundry pig-iron would be greatly broadened and many an iron ore, now unsaleable, would find its way into the market, to the lasting benefit of the world's mineral resources.

Blast-Furnace Practice in the States.

At the same meeting Mr. F. Louis Grammer summed up the past decade in American blast-furnace practice. The administration of some plants was such nowadays, he said, that the superintendent had become a train dispatcher or a burden clerk. The present system required the superintendent to be more a reader of events and men, while the engineer became more concerned with new devices to harness nature.

In the most powerful companies this division of duties had usually resulted in good, but in those plants, like Saxe's razors, "made to sell," many mistakes had been made.

They could look around and see plants well arranged to make iron, but no iron mines to supply them. Others had fine mills, but no furnaces; others, no market. And so the whole decalogue of managerial sins, resulting from a bureaucracy or directorate of untrained iron men, could be run.

In looking over the development of furnace-practice, four steps or incidents appeared as the more important factors: (1) The use of waste gas under boilers; (2) the heating of the blast; (3) the use of coke as a fuel; and (4) the use of Lake ores. Each of these steps has resulted in a doubling and trebling of the output which was possible before their introduction.

Of course, improved refractory materials and better engines were essential, as was also a knowledge of chemistry, but these influences should be regarded as secondary and logical sequences to the others. The better application of the knowledge classified under these four heads represented the development in America.

A decade ago lines of furnaces and cooling devices occupied the thoughts of the furnace world. Since then the advances made might be classified under (1) Conveyors and other mechanical improvements; (2) Metallurgical by-products; (3) Miscellaneous.

The Height of Furnaces.

Impressive as was the metallurgical practice in America, it exhibited inventive ability less than natural resource. They owed more to the regions named after that emissary of peace, Pere Marquette, and the tribes he went out to civilise and Christianise (Menominee and Gogebic), than they did to original research. It was true they had the Uehling pyrometer of American origin, which was an instrument of great precision and of great value to the furnace-man. Their records, however, were characterised by bold application rather than new ideas.

Their high furnaces did not reflect great credit on their designers, though in justice it should be said that most furnace-men were not in favour of 100 ft. heights.

He had personally inspected more than sixty furnaces, and he found that the fuel-consumption, other conditions being equal, was lower on furnaces of from 70 to 80 ft. in height than on furnaces exceeding 90 ft. While Dr. Egleston's records did not include any very high or very large furnaces, the best fuel-consumptions he quoted were in furnaces in the neighbourhood of 75 ft. in height.

AUTOMOBILE NOTES.

By J. W.

Non-stop Runs.

The following are the conditions under which the Automobile Club will recognise long-distance non-stop runs on the road :—

The first consideration is that the run shall be an absolute non-stop run of the motor and the car, no stops of any nature whatever being admitted except for traffic purposes when the motor may be stopped if the driver is called upon to do so, so that any stop whether for tyres or other purposes will be considered as the end of the run.

Every run must start from the Automobile Club, or from the Club House of an affiliated Club, and indication of the intended length of the run and the route to be covered is to be given to the Technical Secretary of the Automobile Club at least a week before the date of the run.

Accumulators or other parts may be changed and fresh petrol may be picked up and put in the tanks so long as neither the car nor the motor is stopped for the purpose.

John o'Groats to Land's End.

The attempt to make an absolute non-stop run between John o'Groats and Land's End proved a failure, inasmuch that closed gates at level crossings barred the way, and droves of sheep twice compelled a halt. The journey was performed in 52 hours and 35 minutes, however, thus beating the record by nearly ten hours. The Argyll Car—an ordinary touring vehicle of ten h.p., was driven by Mr. Douglas Whitehead, relieved by Mr. R. Carlisle.

Motor for Commerce.

The Lord Justice Clerk of Scotland presiding at the annual meeting of the Scotch Automobile Club, remarked that automobilism was not going to be alone a sport of the rich, but a useful agent in the commerce of the country. He was sanguine that during the next three or four years the public would recognise that there was no worse way of carrying locomotion into the country than by turning roads into electric railways. Motors could adapt themselves to the necessities of traffic, and could confer the greatest possible benefits on the public.

We note with interest that the Automobile Club is organising a parade of motor delivery vans.

The object is to encourage the drivers of these vehicles to pay careful attention to their vehicles with a view to reduction of wear and tear and cost of up-keep. Prizes to the amount of £50 will be given to the drivers for the best kept vehicles. A successful service of motor parcel-vans is now in regular operation between Birmingham, Coventry, Kenilworth, Leamington, and Warwick.

The Side-slip Trials.

The cars fitted with non-skidding devices and entered for the Automobile Club's Side-slip Competition, have been engaged in running off the preliminary endurance test of 850 miles. The first prize is to be not less than £100, and may be twice that amount at the discretion of the judges. The actual side-slip trials will be held on the 7th inst., on the private motor track of the Clément-Talbot Company, Ltd., at Ladbroke Grove, Notting Hill, which is being specially coated for the purpose. The following entries are stated in the official programme :—

1. Mr. Samuel Butler—Flat discs on tread held on by steel stems passing through the cover.
2. Mr. H. S. H. Cavendish—Single disc running on ground between back wheels.
3. Mr. W. Hunt—Double roughed discs running on ground between back wheels.
4. Mr. W. Maitland Edwards—Detachable leather band fitted with steel segments riveted thereto.
5. Messrs. Rourke and Horsborough—Double discs running on road between back wheels.
6. Mr. Alex. Nicholson—Steel blades on back wheels with springs; not touching tyres and lifted from contact with road by lever.
7. Mr. Mark Vivian—Tread consisting of alternative sections of hard and soft rubber.
8. Wilkinson Tyre and Tread Company—Fine steel wire staples embedded in tread.
9. W. Jenkinson and Co.—Detachable leather ribbed cover.
10. Commander Chas. Scott — Detachable wire-woven zigzag band on tread, kept in place by side wires.
11. Sainsbury's Anti-Skidders—Spring fork carrying blades each side of tyre, supported on rim.
12. M. L'Empereur—Steel plates connected by links fitted on tread, detachable and kept on by inflation of tyre.
13. Messrs. Grose, Ltd.—Leather band with steel studs.
14. Messrs. Parsons Non-Skid Company—Detachable chains on tread.
15. Messrs. The Civil Service Motor and Cycle Agency, Ltd.—Detachable leather cover fitted with steel studs (Billet).
16. Gare Patent Tyre Company—Combined wood, rubber, and steel wheel.

Numbers 10, 13, and 16 had been withdrawn at the time of going to press.

AMERICAN RÉSUMÉ.

BY OUR NEW YORK CORRESPONDENT.

NEW YORK, April 19th, 1904.

The American Mechanical Engineers.

The American Society of Mechanical Engineers will hold its summer meeting in Chicago, beginning on May 31st, and continuing till June 3rd. The meeting is to be a joint session with the Institute of Mechanical Engineers of Great Britain, and nearly 200 members of the British Institute have expressed their intention of taking part in this meeting.

The New York Rapid Transit Subway.

According to "Machinery," it is expected that the New York Rapid Transit Subway will be opened to the public in June. The work has been a colossal undertaking, not so much on account of the vast quantities of earth and rock to be removed, but because of conducting it in a crowded city through streets carrying a great volume of traffic and beside tall buildings whose foundations were threatened by the excavations. In addition there were the multitude of water pipes, sewers, gas mains, electric conduits and pneumatic tubes with their surface connections, etc., that had to be displaced bodily without interruption of their service or with as little as possible. This work alone is said to have cost the contractors fully $3,000,000. For the greater part of the route, the tunnel was carried on by the "cut-and-cover" plan; that is, it was dug as a ditch and covered over by a roof carried by steel structural work. The tunnel is finished in white glazed brick or tile, and the stations are the same with coloured trimmings, the colour scheme being varied for each station.

World's Gold Output.

According to figures published by the New York "Commercial and Financial Chronicle," the gold output has during the past twelve months increased by 1,456,872 oz., namely 15,894,541 oz., against 14,437,669 oz. in 1902. The countries produced as follows:—

	1902.	1903.
Australia ..	3,949,394 oz.	4,299,234 oz.
Africa	1,998,811 ,,	3,317,662 ,,
United States ..	3,870,000 ,,	3,600,331 ,,
Canada	1,003,359 ,,	943,314 ,,
Russia	1,100,000 ,,	1,134,000 ,,
Mexico	491,156 ,,	500,000 ,,
Other Countries	2,024,949 ,,	2,100,000 ,,
Total ..	14,437,669 oz.	15,894,541 oz.

The greatest increase was in South Africa and Australia, whereas the United States and Canada fell behind. The American output was influenced by the strikes in Colorado, by the drought in California and by the temporary closing of gold and copper mines in Montana.

At the World's Fair.

Among prominent features of the World's Fair may be mentioned a complete metallurgical laboratory with assay department, in operation, the work of the laboratory being done by students of the Colorado School of Mines. The equipment consists of a coal furnace and two gasoline furnaces, with the necessary accessories, four desks for chemical work, and a dust-proof balance room enclosed in glass. There are also eight cases for general display. Regular assays will be made to show the methods of work, and specimens submitted by visitors will be assayed free of charge.

The United States Navy has an elaborate exhibit occupying a floor space of 200 ft. long by 77 ft. wide. It is designed to give an intelligent idea of the internal and external features of American men-of-war, weapons and their use, of the great graving and floating docks in which fighting vessels are placed for repairs, as well as a representation of the actual life and duties of the officers and enlisted men of the navy and Marine Corps afloat and ashore, in war and in peace, together with the Government's facilities for educating officers and its methods of enlisting and training men and boys who compose the fighting personnel of the United States Navy. The biograph will play an important part in illustrating every day life in the navy.

Carnegie Gift.

If it be true that the object of Mr. Carnegie's gift was to demonstrate to the world the spirit of reciprocity and co-operation which pervades among American technical men, a spirit which he found lacking in Great Britain, where, as he put it, each engineer is apt to be an island, the "demonstration" is hardly convincing. The Civil Engineers were against inclusion by a vote of 1,139 to 662. The deciding factors in arriving at this decision by the Civil Engineers were, says a contemporary, doubtless as follows: The possession of a handsome building of their own, practically paid for; the disinclination to merge the fund representing this investment in a building where the American Society of Civil Engineers would be one of four tenants and have a corresponding fraction of control; and finally, the belief—well founded or otherwise—that there would be a decided loss of prestige in abandoning the independent position won through years of patient and hard work.

Be this as it may, it will be noted that Mr. Carnegie is in no wise perturbed. He has renewed his munificent offer to the remaining societies, viz.: the Society of Mechanical Engineers, the Institute of Mining Engineers, the Institute of Electrical Engineers, and the Engineers' Club of New York, and the offer has been cordially accepted.

Some Suggestions and What Came of Them.

Boxes for suggestions by workmen are all very well in their way, but the experiences of Mr. Frank Holz, of the Cincinnati Milling Machine Company, tend to show that they do not pay in the long run. The plan was to pay the employee for any really valuable idea given to the company. The box was filled with many useless suggestions, but one or two were good, and were adopted. For one of these suggestions an employee received $200, and he was advised to take his money home and tell his people how it had come to him. The result was that he did not come back for several days, and when he did come back again, he was not worth much for work. Another employee who received an equal amount, spent it in gambling and on other bad habits, which well-meant

advice and warnings did not break up. Many smaller rewards were paid for minor improvements, but these resulted in contentions and jealousy, so the scheme was finally abandoned. Nevertheless, out of its ashes there arose, Phœnix-like, a better plan, involving monthly meetings of the heads of all departments, shop foremen, and employers. Some shops have found these meetings of such benefit, that they hold them once a fortnight. They have been found to promote a better understanding between the men and their employers.

Consumption of Pig Iron.

The following table from the Bulletin of the American Iron and Steel Association shows the consumption of pig iron in the United States during the last two years.

The comparatively small quantity of foreign pig iron held in bonded warehouses has not been considered. Stocks in foundry yards and in the yards or producers who do not sell their pig iron, always unknown quantities, are necessarily excluded. So also are the stocks held by rolling mills and steel works whose owners do not make pig iron. Warrant stocks are included in unsold stocks.

Pig Iron—Gross Tons.	1902.	1903.
Domestic production	17,821,307	18,009,252
Imported	625,383	599,574
Stocks unsold January 1st ..	73,647	49,951
Total supply	18,520,337	18,658,777
Deduct stocks December 31st	49,951	598,489
Also exports	27,487	20,381
Approximate consumption ..	18,442,899	18,039,907

It will be observed that, while the production of pig iron in 1903 shows an *increase* of 187,945 tons over 1902, the consumption shows a *decrease* of 402,992 tons. The significant fact that the imports of pig iron in 1903 were almost exactly the same as the unsold stocks on hand at the close of the year will not escape attention.

Calculated in the same way as in the table the consumption of pig iron in 1901 amounted to 16,232,446 tons, as compared with 13,177,409 tons in 1900, 13,779,442 tons in 1899, and 12,005,674 tons in 1898. The increase in consumption in 1902 over 1901 amounted to 2,210,453 tons, and in 1901 over 1900 to 3,055,037 tons. In 1900 there was a considerable decrease in consumption as compared with 1899, the falling off amounting to 602,033 tons, while in 1899 the increase in consumption over 1898 amounted to 1,773,768 tons. Below is a table which gives the consumption in the last six years:—

Years.	Tons.	Years.	Tons.
1898........	12,005,674	1901........	16,232,446
1899........	13,779,442	1902........	18,442,899
1900........	13,177,409	1903........	18,039,907

America and Standardisation.

At the annual meeting of the American Institute of Mining Engineers, Messrs. W. R. Webster and E. Marburg reviewed the progress made in the standardisation of specifications for iron and steel in both England and America.

When the International Association for Testing Materials was organised at Zurich in 1895, a committee was appointed, charged as follows:—

"On the basis of existing specifications, to seek methods and means for the introduction of international specifications for testing and inspecting iron and steel of all kinds."

The American representation on this international committee consisted originally of five and now of eight members. In view of the magnitude and importance of the subject, the Executive Committee of the American Section of the International Association for Testing Materials, since incorporated as the American Society for Testing Materials, appointed a committee of thirty-four members, including the American members of the above-named international committee, to frame standard American specifications for iron and steel. This committee reported on specifications for (1) Structural Steel for Bridges and Ships; (2) Structural Steel for Buildings; (3) Open-Hearth Boiler-Plate and Rivet-Steel; (4) Steel Rails; (5) Steel Splice-Bars; (6) Steel Axles; (7) Steel Tyres; (8) Steel Forgings; (9) Steel Castings; (10) Wrought Iron.

These specifications were designed to be fairly representative of the best current American practice, and were adopted by letter-ballot of the Society in August, 1901.

The leading engineering societies have participated at various times in the discussion of these specifications and have lent valuable assistance through the appointment of special committees on like or closely related subjects.

It is shown that the existing differences between the leading American specifications framed within recent years are in the main on matters of minor importance, and what has been done has resulted in a considerable clearing of the atmosphere. That further efforts will be put forth to reconcile the remaining differences as far as possible cannot be doubted. If the task be approached in a fair and open spirit of compromise between interests whose divergence, broadly viewed, is more apparent than real, all parties will be the gainers. If this work be promptly initiated, it is not too much to hope that American standard specifications approved by the leading technical societies, and covering the principal iron and steel products, will be available for presentation at the Seventh Session of the International Railway Congress to be convened in Washington, D.C., in May, 1905, and that they will prove an important step towards the ultimate realisation of international standard specifications.

SOUTH AFRICAN RÉSUMÉ.

BY OUR JOHANNESBURG CORRESPONDENT.

JOHANNESBURG, April 12th, 1904.

Transvaal Quarterly Output.

The following figures from the usual official source show the mineral output of the Transvaal for the last quarter of 1903 :—

GOLD.

Month.	Yield in oz. Fine.	Value in £ sterling.
October	285,550	1,212,935
November	280,803	1,192,778
December	287,811	1,222,545
Totals	854,164	3,628,258

SILVER.

Month.	Yield in oz. Fine.	Value in £ sterling.
October	33,366	3,623
November	33,402	3,624
December	31,407	3,439
Totals	98,175	10,686

COAL.

Month.	Tons sold.	Value realised at pit.
October	195,190	74,718
November	186,060	70,916
December	192,784	73,307
Totals	574,034	218,941

DIAMONDS.

Month.	Carats.	Value £.
October	28,895	39,931
November	29,701	40,077
December	30,120	41,298
Totals	88,716	121,306

Increase in Diamond Output.

In June last the Transvaal produced only 15,425 carats, so that the output has been practically doubled during the last six months, and at present the monthly production is nearly equal to the total for the statistical year ending June, 1903, which amounted to 33,573 carats. But even now the Kimberley district alone produces ten times as many carats as the whole of the Transvaal.

Natal Ports.

This enterprising colony continues its efforts to secure its share of the South African trade. The result of the dredging at Durban showed a record channel during February, when the *Essex* steamed across the bar with a draught of 24½ ft. During the same month the floating dock was safely towed into the harbour and placed in position with the accompaniment of a seven-gun salute and the cheers of thousands of spectators.

A detailed survey which will occupy several months is to be made of St. Lucia Bay, to which reference has been previously made in these notes, as a possible new port for this colony in Zululand.

Durban Electric Lighting.

At the annual dinner of the Corporation Electric Light Department, held recently, in Durban, the great expansion of the supply was referred to, and it was stated that, whereas the plant started in 1898 with 196 connections and 9,320 lamps, there are now 2,209 connections and 90,000 lamps. There are also 700 incandescent street lamps and 190 arc lamps of 1,000 candle-power, which, as well as the power for trams, have to be supplied from the central station. The power provided is 4,325 h.p.

Orange River Colony.

The stagnation in the Transvaal Mining industry, due to want of coloured labour, is reacting upon the Orange River Colony, where relief works are being carried on to alleviate the distress amongst the white population. At the present time railway cuttings are being widened in view of the future doubling of the lines in order to find employment for the men who come to the relief camps.

In order to broaden the industrial conditions of the colony, a commission has been appointed to report upon the possibility of promoting, by means of Government assistance, the establishment of new and minor industries for which the necessary raw materials are now available. The following list of suggested enterprises; which may be considered and reported upon by the commission, may be of interest to European makers of industrial machinery : Spinning, weaving, blanket, carpet and basket making, leather tanning, with manufacture of boots and harness ; the making of jams, biscuits, and cigars ; preparation of oatmeal, cornflour, starch, chicory, indigo, manufacture of furniture, rope, pottery, tiles, cement, etc.

It is obvious that the above list includes some articles which could not be manufactured profitably on a small scale without the imposition of distinctly protective tariffs, and others which would need the importation of specially skilled workmen for their production.

Mining Costs in Rhodesia.

The Rhodesian Chamber of Mines has issued the following details showing the relative costs of labour and materials in their mines, with a view to emphasising the necessity for the lowering of railway rates wherever possible, these forming an important part of the total cost of supplies. The data are compiled from the returns of eight producing mines, which have produced over 95,000 ounces of gold bullion :—

Items.	Cost.	Percentage of total.	Cost per oz. s.	d.
Salaries	21,144	7·47	4	5·09
White wages	55,208	19·50	11	6·48
Contractors	9,020	3·19	1	10·63
Native wages	46,076	16·27	9	7·56
Fuel and charcoal £36,203				
Natives' food .. 22,089				
Other stores .. 72,831				
Total "supplies"	131,123	46·32	27	4·92
General expenses ..	20,530	7·35	4	3·48
Totals ..	£283,101	100·10	59	2·16

GERMAN RÉSUMÉ.

BERLIN, April 22nd, 1904.

German Exhibits at St. Louis.

Germany is to be well represented at the St. Louis Exhibition in spite of fears to the contrary. Among the exhibits may be mentioned: Machinery—steam engines, 8 exhibitors, including the famous "Vulcan" Works at Stettin; power machines of various kinds, 1 exhibitor; general adjustments for machine-working, 6 exhibitors; machine tools, 6 exhibitors. Electricity, electric lighting and electricity in its various uses, 7 exhibitors. Traffic and transportation, carriage building, automobiles and cycles, 7 exhibitors, including Benz and Co., Mannheim, the Daimler Company, Cannstatt, Continental Caoutchouc and Gutta Percha Company, Hanover, and the Mitteldeutsche Rubber Goods Works, Frankfurt a. M. Railways, terminals, stations, freight depots, and equipment in general under the auspices of the Prussian Ministry of Public Works, 9 exhibitors, including Siemens and Halske, Berlin, Henschel and Sohn, Cassel. Equipment for mercantile marine, 9 exhibitors, including both the great German steamship lines—one firm exhibits naval material and equipment. Ballooning and aereonautics, 6 exhibitors.

Mining and smelting works: collective exhibit arranged by the Royal Prussian Ministry for Trade and Commerce, 21 foremost German firms. Minerals stones, and their employment, collective exhibit of the amber industry, 16 exhibitors. Metallurgy, 3 exhibitors.

Among those exhibiting in the group for geographical, cosmographical, and topographical maps and requisites are: Justus Perthes, Gotha, Dietrich Reimer, Berlin, publisher of Kiepert's atlases and maps, Velhagen and Klasing, and others. The collective exhibit of German art photography includes 34 professionals and 24 amateurs, among the latter the Lette Verein of Berlin. Engineering models, plans, drawings, and public works, which group is under the auspices of the Prussian Ministry of Public Works, includes 10 representative firms, such as the Siemens-Schuckert Works and the Augsburg-Nuremburg Machine Works. The builders of the new Teltow Canal are also represented in this group.

Cutlery goods, processes and products, 3 exhibitors; gold and silverware, 13 exhibitors; marble, bronze, cast and wrought iron objects, showing equipment, process and output, including leading Berlin and Munich firms, 30 exhibitors.

A Proposed Overhead Railway.

For a long period, engineers have been considering the question of a North to South quick transit railway in Berlin. Mr. D. Feldmann has been describing, in the German technical press and "Railway Bulletin" a method of construction which he claims would be the cheapest and most efficient method. The proposed railway would run between Anhalt and Stettin stations. To run such a railway at street level, says Mr. Feldmann, or at such a height as the old City Railway or as the Siemens Elevated Railway, is, of course, quite out of question. The houses and buildings which would have to be pulled down or interfered with would involve enormous expense, and going across *Unter den Linden* would never be permitted. On the other hand, a four-track underground railway, with sufficiently large stations and with the severe gradients necessary would, even if at all possible, be far too costly.

Thus the construction of a North to South railway seems only possible from the technical as well as the economical point of view, if the railway is sufficiently high above ground to cross over the houses and not to interfere with any of them, except, perhaps, with the roofs of a few exceptionally tall buildings. At first sight, this proposal would appear to be a bold one, but careful consideration shows that a plan and method of construction can be devised, which appears comparatively easy of execution, or at least worthy of all attention.

The clear height must amount to 82 ft. to 98 ft. 5 in., and the spans must vary between 197 and 295 ft. Very many bridges of similar heights are in existence; there are even viaducts three and four times as high. The intermediate piers can be placed without difficulty either in the courtyards or over and in the rear building. There is no reason why all the spans should be of uniform length; similarly the shape and dimensions of the piers can be made to suit the different localities. Not many rear buildings will have to be interfered with, and the compensation to be paid will be comparatively limited in amount.

The two pairs of tracks can be placed side by side or one over the other. The latter arrangement is however only to be adopted if electric traction is used on the lower pair of tracks, which are those carrying the City and Girdle Railway trains. The best route for this new City Railway would be approximately central to the blocks between Charlottenstrasse and Friedrichstrasse. The line from the Stettin station to where it crosses the Kochstrasse can be absolutely straight, which would be of great advantage from the point of view of construction. To put up the usual scaffolding along the whole route would be quite impracticable; but, owing to the straightness of the line, it will be possible to build it while using hardly any scaffolding.

Proposed Method of Construction.

A little before Stettin station, the new railway will curve somewhat to the left. It appears advisable to erect, in the same straight line as the straight part of the track, a stage next to the station buildings and over the goods station, such stage being of sufficient length to deal with the largest span on the new railway. The material used for construction will be brought on trucks below this stage, or alongside it; the spans are then to be constructed there, or at least their main parts put together, and then the whole construction, as and when put together, is to be pushed forward to the south until the front end reaches the Kochstrasse.

The intermediate supports will, of course, have to be put up previously, by means of special scaffolding; and if they have not sufficient stability of themselves, they can be guyed temporarily by the use of wire ropes or other devices. At the top of them rollers are to be placed, over which the completed track can roll. As soon as the friction becomes so great, that the track can no longer be pushed on from Stettin station, the rollers are to be rotated so as to assist the advance of the track. Whether continuous girders or separate independent girders or any other girders are used, the whole track is in the first instance put together as a continuous girder by temporary connections, and these connections are only removed when the girders are in place—that is, when the whole is completed. In calculating out the girders, the stresses produced during the operation of pushing on the track must be allowed for.

At the front end of the track the projecting part will have to be of special construction, to prevent too great flexion when free and overhanging.

MINING NOTES.

BY A. L.

Coal Cutting by Machinery.

A remarkable extension in the use of coal-cutting machinery is evidenced in the twenty-eighth annual report of the chief inspector of Mines, Ohio, for 1902. Mr. Biddison points out that in 1889 only 900,000 tons (or about 8 per cent. of the output) were produced by machine, as compared with 13,439,648 tons (or 55 per cent.) in 1902. During 1902 there was a gain of thirty-three in the number of mines using machinery, whilst the number of machines at work increased from 429 to 574. Of the total number of machines at work, 527 were of the electric type and 47 compressed air. Mr. Biddison says the time is not probably far distant when the use of the pick will be discontinued, and that the use of machinery will permanently take its place as the most successful method of mining coal.

A Reference Work for Miners.

I have received from Mr. M. Walton Brown a copy of his carefully compiled "Subject-Matter Index of Mining, Mechanical and Metallurgical Literature for the year 1901." This is arranged as follows: Contents—Alphabetical List of Publications Indexed—Geographical Index to the Alphabetical List—Subject-Matter Index—List of Authors. The Subject-Matter Index, which occupies the greater part of the work, includes the following headings: General, Geology, Mineralogy and Crystallography, Chemical Investigations, Physical Investigations, Surveying and Levelling, Mining Technology, Quarrying Technology, Metallurgy, Salt-works, etc., Chemical Industries, Ceramic and Glass Industries, Building Construction and Materials, Machinery, Electrical Investigations, Navigation, Surface Transport, Railways and Tramways, Administration and Statistics, Directories, etc.

Mining in New South Wales.

The aggregate value of the mineral wealth produced in New South Wales to the end of 1903 is estimated at £158,339,798. The value of the production for 1903 is £6,059,486, and is a net increase of £421,341 over that of the previous year. The total number of persons employed in and about the mines of the State during the year under review is computed at 37,739, and is an increase of 4,044 persons on the year 1902. The estimated total value of the machinery erected at the mines, other than coal and shale mines and inclusive of the value of the dredging plants, is £2,097,710. This does not include the value of the plants of the various smelting companies. The gold yield for the year was 295,778 oz. crude, equal to 254,260 oz. fine, valued at £1,080,089. In addition gold to the value of some £612,334 was obtained by the smelting companies from auriferous ores imported from other States and treated here. It has to be explained that the system of collecting the gold yield has been revised, and in connection with that of the year 1903 an apparent decrease of £744 is shown in the value as compared with the production recorded for 1902, but the returns for 1902 include gold obtained by the smelting companies from imported ores, whilst those for the year 1903 are confined wholly to gold won from ores in the matrix and from alluvial deposits mined in this State. Instead, therefore, of a decrease occurring, there is actuallly an increase of £395,059 in the value of the gold won in this State during the year.

Miners' Phthisis.

At a recent meeting of the Mining Institute of Scotland, Mr. James Barrowman, in the course of a paper on "Miners' Phthisis," drew attention to the fact that the conclusions of the Miners' Phthisis Commission with regard to the highly dangerous nature of the dry dust in the mines of the Transvaal have been strikingly corroborated by the experience of those engaged in the construction of the Simplon tunnel. Arrangements are there made whereby all drill-holes are bored wet, and systematic measures are carried out to lay the dust. Cases of phthisis are rare among the workmen there, whereas in the St. Gothard tunnel-works where the same precautions were not taken, the mortality from phthisis was very high. It is much to be desired that the results of the investigations of this Commission should be known as widely as possible, in order that the urgency of reform may be brought home to all concerned. It should not be inferred, however, that death is being dealt out in similar fashion in the mines of this country. So far as Scotland is concerned, the lead-mines of Wanlockhead and Leadhills are the only metalliferous mines of considerable extent, and the working conditions there are quite different from those of the gold mines of the Rand, the drilling being done entirely by hand and water being abundant. And, as for coal-mining, practical experience and expert research make it clearer every day that lung-disease as a result of breathing coal-dust is not a prevalent disease among colliers. Unlike the sharp and irritating dust produced in the mining and tunnelling of hard and gritty rocks, the dust of coal is softer, more rounded, and comparatively harmless. The only conditions in coal-mining at all approaching those of the Rand gold-mines may be on the rare occasions where, in a dry colliery, long stone-mines or drifts are driven in gritty rock, without arrangements being carried out for watering the drill-holes. No doubt the dust of coal-workings always has a certain admixture of gritty particles derived from the strata connected with the coal, and this is an element worthy of some consideration from a sanitary point of view.

The World's Copper Output.

The world's copper statistics, compiled by Messrs. Aron Hirsch and Son, and published in detail by the "Mining Journal," show a remarkable increase, attributed to the fact that improvements in technology have rendered many old mines remunerative at greater depths, while the numerous advances in haulage appliances have enabled levels to be worked at a profit which in earlier times had to be abandoned.

Remarkable fresh discoveries of copper have also been made in all parts of the world. Only in this way can it be explained that the total production of the globe which in 1801 amounted to only 9,000 tons, had risen in 1850 to 30,000 tons, while since that date the production has progressively increased to 542,470 tons in 1902 and 589,361 tons in 1903, whereas in 1891 we only had a total production of 279,309 tons. The total output therefore has nearly doubled in the short period of a single decade. The lion's share in this rapidly increased production falls to America. The United States produced in 1891 128,175 tons, and in 1903 318,861 tons. In 1880 the production of the United States was only 27,000 tons. In 1891 the production of Mexico was 900 tons. In 1903 it was 48,000 tons.

OUR TECHNICAL COLLEGES.

By A TECHNICAL STUDENT.

Education and Business Success.

Little time has been lost in issuing the report of the Mosely Education Committee, which, we need scarcely remind our readers, was based upon the idea that education must be responsible for much of American success in business. Mr. Mosely is personally convinced that honesty, doggedness, pluck, and many other good qualities possessed by Britons, though valuable in themselves, are useless to-day unless accompanied by practical up-to-date scientific knowledge, and such knowledge only becomes possible with an enlarged and enlightened system of education, such as the United States possesses.

There is no doubt much truth in this observation, but, as Mr. Papillon has pointed out, there are other equally potent causes of American success. "The energy, 'hustle,' and inventiveness of the American character; the early hours and absorbing claims of business; the universal high-pressure race for wealth; the close touch between employers and employed, and readiness to act upon the view that capital and labour have common and not antagonistic interests; and, it is to be feared that we English must add, the greater sobriety of all classes among them—these are pushing America to the front."

Education, says Mr. Papillon, though a contributory cause, has not hitherto been the chief cause of American industrial progress. It has shared and is sharing in that progress, or, as President Roosevelt puts it, "education will not save a nation, but no nation can be saved without education." Strong emphasis is laid upon the fact that in America educational progress has been helped on by the goodwill of the people and their universal belief in its value as an investment.

American Methods Not Perfect.

At the same time, it has been rendered quite clear that the Americans are, as it were, merely groping their way to the successful determination of educational problems. Professor Armstrong does not hesitate to say that the entire system of education, both here and in America, seems to require reconstruction from bottom to top; "it would be well, if I may say so, if we could scrap the whole wretched academic show, and start afresh, in order that it may be greatly improved in quality and shortened in duration."

That American methods are not perfect seems to be well recognised across the Atlantic. For instance, the "Electrical World and Engineer," discussing Dr. Walmsley's recent investigations under the heading "As others See us," remarks that he (Dr. Walmsley) "puts a keen analytic finger on the very points which we have often recognised as weak spots in American technical education. His many conversations with American manufacturers brought out as the most general criticism 'that in many cases the training is too superficial and too apt to overload the student with a large and confused assortment of facts instead of training him in principles, this being in a large measure due to attempts to deal in too much detail with a crowd of subjects, especially in the last year of the course." And with respect to one egregious fad in recent education, Dr. Walmsley remarks: 'It is a matter for serious consideration whether the excessive amount of time given to manual work in the manual training schools has not been dearly purchased at the expense of starving the time which should have been given to mental training.' We wish that some of our strenuous and solemn-visaged educators who spell themselves in large capitals and have so little sense of humour as to take themselves seriously, would cut out these two quotations and paste both into their hats. As things are at present, the higher technical institutions are busy for no inconsiderable part of the course in stopping the gaps left by kindergarten foolishness of various sorts in the primary and secondary schools. They admit students at eighteen or nineteen years of age and then spend the better part of two years in teaching them the elementary English, mathematics and modern languages that have been neglected in the secondary schools to make room for nail-driving, music, painting, and emasculated physiology. It is vast credit to the technical schools that in a four-years' course they can turn off the material they do in spite of inefficient preparation. Our English friends, in trying to build up a system of technical education will at least have less foolishness to contend with at the start. The thing most needed over there, however, is the sympathetic assistance of the great universities. So long as they hold aloof from directly encouraging technical students, the tremendous weight of their centuries of social influence will stand against improvement."

A Sir William Allan Scholarship.

The Principal of the Sunderland Technical College (Prof. B. Branford) has laid the following letter, which he has received, before the Higher Education Committee:—

15, Humbledon View, March 11th, 1904.

Dear Sir,—Confirming our interview of to-day, I beg to intimate, on behalf of Lady Allan, that she is prepared to found a scholarship, or prize, at the Technical College, on the following terms:—

1. A capital sum of £500 to be invested in the names of three trustees, the interest on which investment would form an annual fund available for the scholarship.

2. The scholarship to be always called "The Sir William Allan Scholarship."

3. The scholarship to be only open to *bona-fide* apprentices at marine engineering works in the town (that is, on the Wear).

As to the details, and as to whether the scholarship should be awarded annually or triennially, Lady Allan will be glad of the vews of yourself and your committee, which she will consider very favourably.

Will you kindly lay the matter before the Technical Education Committee for their consideration?—I am yours faithfully. (Signed) Walter B. Allan.

To Principal Branford,
Technical College, Sunderland.

The Committee have passed a resolution thanking Lady Allan for her generous offer, and intimating that the matter would be sent forward for the consideration of the whole Education Committee.

Engineering Ideals.

Sir W. H. White, distributing the certificates gained by successful students at the Crystal Palace Company's School of Practical Engineering, said that twelve years ago he attended the school to perform the same pleasant duty which he was about to do that day. On the former occasion he went carefully through the school, and he had done so again that morning; and he was much pleased to be able to say that the good features which he noted twelve years ago had been maintained. Many new features had been introduced, adding greatly to the utility of the school, and the number of students was still fully kept up—the number which those who were charged with the conduct of the school desired to have. The number of students might be increased no doubt, if the instructors were increased also; but, in his judgment, the number upon which the school was based by the father of the present principal,—namely, 100—was a good one, for it was desirable to restrict the number to within the limits which ensured personal attention being given to each student. The school was founded in 1872, and since that time 1,600 students had entered it, and of those over 800 now occupied positions of more or less importance in the engineering profession. He came there that day to express not only his own personal interest in the school, but that also of the Institution of Civil Engineers, which was by far the greatest engineering institution in the world, was international in character, and comprehended all classes of engineering except the military. Out of the whole body of students trained in the school, no fewer than twenty were now full members of the Institution of Civil Engineers, 175 had become associate members, and 300 had come as students—facts which indicated how fully that institution had recognised the excellence of the training and instruction given in the Crystal Palace School. The Palace Company, in giving to Mr. Wilson, more than thirty years ago, the opportunity of establishing the school, rendered a great service to the cause of technical education. Those who knew what the state of technical education was thirty years ago would agree with him that the Palace directors did then a very remarkable thing in founding the school; they followed up primary education with a good system of secondary education having special reference to engineering, and the excellent results of their action were apparent. The true ideal of engineers was to make their profession a means of advancing the peace, progress, and happiness of humanity by carrying out those great works that brought the peoples of the world into closer contact with one another. That was an ideal worthy of any man's devotion; but the students must bear in mind that it could not be realised without the possession of high scientific knowledge and thorough training. In the Palace School, he was glad to say, practice and theory both had their due recognition, and that was the right foundation for an engineer training, since no training could be effective which did not combine the two.

Transvaal Technical Institute.

A very noteworthy circumstance in the history of South Africa has been the formal opening of the Transvaal Technical Institute. This, according to the *Times* correspondent, is intended to be the nucleus of the future University which, in the opinion of the commission appointed by the Government to gauge the needs of the community in the matter of technical education, will ultimately be found necessary for the Transvaal. The commission, however, rightly decided to make an immediate start.

The Institute, as now inaugurated, has absorbed the Kimberley School of Mines, which for eight years has covered the third and fourth years' courses prescribed by the Cape University for obtaining a degree in this subject. A course in general engineering has been added to enable students to put in their whole time here, while evening classes for others will shortly be begun. In view of the exceptional opportunities afforded at Johannesburg for mining engineering, arrangements are on foot to enable students of the Royal College of Science and other home institutions to proceed to the Transvaal for a year's post-graduate study. It is understood that several mining houses will offer positions in connection with the mines to such students at a small salary.

The question of the development of the institute is occupying the attention of Professor Hele Shaw, the organiser, and of the Council for Technical Education, which is representative not only of the technical scientific bodies but of the whole community. This council, on which devolves the decision regarding the permanent housing of the institute, may be trusted to approach the question with professional knowledge, while it will be at the same time in close touch with the wishes of the people of the Transvaal. In the meantime, the institute has begun its work in the former Boys' High School, and will continue to occupy temporary premises until such time as it is possible to erect permanent buildings on a scale worthy of the cause and of the colony.

Are We Going Too Fast with Scientific Education?

Dr. A. B. W. Kennedy, who gave the toast, "Scientific Education," at the annual dinner of the Institution of Mechanical Engineers, commented upon the progress which the scientific teaching of engineers had made during the past thirty years. In 1874, he said, there was in London hardly a single complete engineering course of any kind; now, no important town in the country felt that its educational system was complete unless it included a full engineering course. He was not sure that we were free from the danger of going a little too fast in the matter of scientific education, so far as their profession was concerned. They would never get the scientific side of engineering properly dealt with unless their teachers could be persuaded that science was not an end in itself, but a means to an end. Sir Edward Fry, who proposed the toast of "The Institution of Mechanical Engineers," remarked that the Institution was founded in 1847, and at the close of last year, the membership numbered upwards of 4,100.

NOTABLE BRITISH PAPERS.

A Monthly Review of the leading Papers read before the various Engineering and Technical Institutions of Great Britain.

THE UTILISATION OF BLAST-FURNACE SLAG.

AT a recent meeting of the West of Scotland Iron and Steel Institute, Mr. E. R. Sutcliffe read an instructive paper, on the "Utilisation of Blast-Furnace Slag." He remarked that the utilisation of waste was receiving great attention in all branches of business. In no other manufacture was there such a vast quantity of waste as in the smelting of iron, and there was no doubt that in future the utilisation of this material would form a most profitable adjunct to that of the manufacture of iron. Great strides have already been made in this direction in France, Belgium, and Germany.

In this country, said the author, very little is being done. Certainly slag is being used to make paving flags, bricks, and cement to a small extent; but practically, beyond what is used for ballast purposes and general concreting and foundations, very little is utilised. The various works which have been erected for utilising slag have demonstrated that slag cement, Portland cement, paving bricks, building bricks, paving flags, and tiles of an excellent character may be made from slag; but in this country we must turn our attention chiefly to the manufacture of Portland cement, building bricks, paving flags, and tiles. Slag cement made by grinding together dried granulated slag and hydrated lime, will not probably be made in this country to any extent—very few slags being suitable for treatment in this way, whereas Portland cement may be made from most slags. And when it is considered that the chief cost in Portland cement manufacture is in power and fuel burning, and that most ironworks do not know how to utilise their heat to good account, there must be a big future before this method of utilisation. At present where Portland cement is made from slag the cement is clinkered by either coke or coal, and only the power is generated from the furnace gases; the difficulty being in getting a sufficiently high temperature (1,400 degs. to 1,500 degs. C.) with the furnace gases to clinker the cement. This, however, is a difficulty which no doubt will shortly be surmounted.

BUILDING-BRICKS.

Building-bricks from slag at present are principally made from granulated slag; the method adopted being to intimately mix with the slag from 6 to 10 per cent. of slag cement, hydraulic lime, or Portland cement. This mixture is then moulded into bricks under pressure; the pressure exerted on each brick being from 50 to 100 tons. The bricks are then stacked in the open air, where they are allowed to stand for three months to harden. In wet weather they must be kept under cover for the first few days before exposure; and in cold weather they require protection from the frost for the first few days. This method is the one chiefly adopted in France, Belgium and Germany, where the bricks seem to find great favour. They are of excellent quality, and well adapted for foundation work, but are somewhat porous in character. The plant required is of the simplest character; being confined simply to the mixing machinery and brick-making machine.

ARTIFICIAL PAVING FLAGS.

Concrete paving slabs are now largely used, and the demand for them is rapidly increasing. They are much cheaper than natural paving materials, and are less costly in laying. They wear more evenly, and, being homogeneous, do not split and break away like a natural stratified paving material. Blast furnace slag is a material particularly adapted for being made into concrete, and when suitable slag is used, and reasonable care taken in the manufacture, most excellent paving flags may be made.

Paving flags from slag may be made either from granulated slag or by using crushed slag to which a proportion of Portland cement is added, usually 2, 2½, or 3 of slag to 1 of cement. The mixture is made into a slurry state with water, and pressed under hydraulic pressure in moulds with a perforated bottom over which a filtering medium is placed, 400 to 600 tons total pressure being put on a flag of the size of 2 ft. by 3 ft. The pressure squeezes the excess water out of the mould, leaving the slab comparatively dry and hard. On removal from the machine, the slabs are allowed to stand on receiving boards for about three days, after which period they are stacked in the open air, six months being required to effect the final hardening. In dry weather the flags should be watered occasionally, or, better still, immersed in water for a few weeks.

This method is the one generally adopted also for making paving flags from granite chips, destructor clinker, and other materials. Some excellent flags are made by hand from these materials and from crushed slag, the material being mixed like ordinary concrete and then pressed into moulds laid on the floor, the top face being smoothed with the trowel. In such cases the flags are kept in the moulds on the floor for a few days before stacking on edge in the open air.

In the author's opinion, however, hand-made flags are not equal to hydraulic pressed flags. They always contain air spaces, never found in a well pressed flag.

RECENT DEVELOPMENTS IN CARGO AND INTERMEDIATE STEAMERS.

AT the ordinary meeting of the Institution of Civil Engineers, on Tuesday, the 12th ult., Sir William H. White, K.C.B., President, in the chair, a paper on "Recent Developments in Cargo and Intermediate Steamers," was read by E. W. De Rusett, M.Inst.C.E. The paper covers more particularly the period since 1899, in which year the author presented a brief note on the subject to the Engineering Conference. The following is an abstract:—

TYPE.

The "shelter decker" is still in favour for special service, and the design of the "single decker" has developed in the production of holds clear of beams and pillars, having a great advantage, especially in the carrying of such cargoes as coal, grain, etc. Tank vessels adapted not only for conveying oil in bulk but also for carrying ordinary cargoes are now largely used. The demands of the fruit-carrying trade have brought forth a special class of steamer fitted with refrigerating plants, and, notably, those trading to the West Indies, are very successful.

SIZE.

Here depth of water in ports, docking facilities, etc., control development, but, nevertheless, great advance has been made. The ships of over 3,000

tons register under construction in the periods 1896-99 and 1900-1903 numbered 718, and indicate a marked increase in size, especially from 7,000 tons and upwards. British superiority in the matter of shipbuilding is remarkable, in spite of keen competition. During the last four years, in the matter of large ships, the British numerical output increased 37 per cent., tonnage 59 per cent., and average size 16 per cent. on the previous four years. America and Germany have developed the shipbuilding industry immensely of late years.

CONSTRUCTION.

The few features noticeable about five years ago are still largely in evidence, such as the flanging of internal work, joggling of frame bottoms, and girder framing, whilst the stiffening of water-tight bulkheads is more rationally arranged. Continuous hatch-coamings, not extended below the deck level, have been introduced. The flanging of the tank side to the shell and the extension of it up the bilge past the level of the bilge keel, has been an improvement. In one case, the practice usual in men-of-war has been followed, the tank side being extended to the lower hold-stringer, resulting in more space for water-ballast and in increased safety.

CAPACITY.

Vessels of 12,200 tons dead-weight and a measurement capacity of about 20,000 tons, at 40 cubic feet per ton, have been very successful. These carry passengers as well as cargo, and have proved exceptionally comfortable. An interesting cargo manifest of a large intermediate liner, appended to the paper, shows 231,300 items and a weight of 9,260 tons. Another vessel carried 39,433 barrels of apples, weighing 2,960 tons, besides 71,000 bushels of wheat, and other miscellaneous cargo. Colliers of 7,000 tons, ore-carriers of 10,000, and "tankers" of even greater capacity indicate great industrial activity and progress.

CARGO APPLIANCES.

Speedy loading and unloading is of the utmost importance, and therefore special attention has been paid to this matter. Winches are more numerous and are run at higher speeds, manilla and small steel-wire runners are used; more derricks are fitted; and the hatchways are larger. Steel hatch-covers, hinged to coamings with patent fastenings, are now used, and do away with the beams.

As an example of what a modern cargo-steamer can accomplish, mention is made of a vessel of 6,000 tons dead-weight, which made 36 voyages of some 55,000 miles in 11 months and 19 days, loading, carrying, and discharging a total of 210,600 tons.

The "turret" class have been markedly successful. One vessel, the "Grängesberg," with twelve large hatchways and twenty-four derricks, worked by twelve double-ended winches, has discharged 10,000 tons of ore in 35 hours. Temperley transporters are largely used, but without grabs. There is ample room for suitable electric winches for this class of work.

BALLASTING.

Increasing need for making half the passages in ballast and bunkers only have called for more attention to ballast-tanks. The adoption of high-wing-tanks for about half-length amidships, has been tried with success, giving a metacentric height of 3 ft. 9 in. in one case. Similar has been the result of McGlashan's system of making a double skin as high as the upper deck, for about half the vessel's length amidships. The plan of carrying the water in special 'tween-deck tanks demands the increase of scantlings, which somewhat diminishes the advantages, but this is less costly than the building of deep tanks. Deep tanks in addition to a double bottom is the usual arrangement, but is only suitable for vessels making long voyages. Some boats with longitudinal centre-line bulk-heads omitted in tanks of 27 ft., holding 1,400 to 1,500 tons of water, have been very satisfactory, being able to discharge this huge volume of water in about five hours. Careful distribution of weights has reduced the strain to a minimum.

ECONOMY OF WORKING.

The design of a vessel vitally affects the consumption of fuel. Vessels of 20,500 tons, making 15½ knots, on a consumption of 140 tons of coal per day; of 19,000 tons, at 15 knots, on 115 tons; of 11,600 tons, at 11·35 knots, on about 46 tons, are a few instances of what has been accomplished in the way of economical running. Careful comparison of the costs of land and sea conveyance gives remarkable results. In fact, taking 1·54d. per ton per geographical mile as the cost of carriage by mineral train in this country, it is found that the inclusive expenses incurred when sea-borne is only about $\frac{1}{15}$ of this figure. The passenger traffic yields figures scarcely less striking. A transatlantic passage, *including* board, costs ·44d. per mile; the accommodation for the third class being luxurious as compared with that of a few years ago. Liquid fuel does not seem on the whole to be making headway, a fact which appears to be largely due to the existing monopolies in this valuable product.

THE ENGINEER'S SIDE OF THE SEWAGE QUESTION.

A PAPER on the "Latest Practice in Sewage Disposal," contributed by Mr. Henry C. H. Shenton to the Society of Engineers, laid emphasis on the practical or engineer's side of the question.

SYSTEMS IN VOGUE.

The author first pointed out that the practical engineering side of the question of sewage disposal as distinguished from the theoretical side had not received the attention it deserved in papers read on the subject. He then briefly reviewed the present methods of sewage disposal in the following order: Natural and artificial precipitation; upward filtration, and the septic tank system, all for the removal of sludge. Broad irrigation, lateral filtration, and downward filtration, on land. The fine filter; the washed-out filter; the contact bed; and the continuously aerating filter. He stated that a careful examination of existing works throughout the country led him to the conclusion that each and all of the foregoing systems had their uses, and produced good results in certain cases. The biological methods, he said, included every recognised system of final sewage purification.

SEPTIC TANKS.

Mr. Shenton is of opinion that the septic tank needs most consideration as regards the methods for the first stage of sewage purification. The best methods of precipitation have been well thought out long ago, and are not generally economical or so suitable for ordinary works. The septic tank s used as a preliminary for land treatment, for filters, or contact beds, or for continuously aerating filters.

and has to a great extent replaced the older methods, being more economical and a much better preliminary for the aerobic action to follow. There is not the slightest doubt, whatever prejudice one may at first have had against the septic tank, that it is practically a most useful, and even indispensable, part of the greater number of the smaller sewage works recently constructed.

In the author's opinion, the dimensions and details of construction of the septic tank need careful consideration by the engineer. At most places the depth does not exceed 7 ft., but the author is of opinion that it is possible that the depth of 7 ft. might be increased with advantage. It is very evident to him that 7 ft. is near the minimum depth for a septic tank, especially if that tank is only lightly covered.

A HOPELESS ARRANGEMENT.

Perhaps the most general practice at sewage disposal works has been to turn the old chemical precipitation tank into a septic tank; such a tank is often 5 ft. deep at the inlet end, and 4 ft. 6 in. deep at the outlet end. The first thing done has been to simply let the sewage run through it without any scum board or trapped outlet. Any amount of solid matter has come out with the effluent, but a great deal has been liquefied also by the septic action, with the result that the amateur engineers of the district have been much pleased at the successful application of theoretical principles, and that a certain definite saving has been effected by getting rid of the sludge difficulty. The contact beds or filters, however, have later on become clogged, and the contact bed principle has been severely blamed in consequence. Later on the septic tank—or so-called—has been found to be sludged up, and has had to be emptied, and the district councillors of the place where such occurs will tell you that engineers have still a great deal to learn on the subject of sewage disposal.

IMPORTANT POINTS IN SEPTIC TANK WORK.

In the course of further remarks, Mr. Shenton said he considered the best form of tank, under ordinary conditions, was one covered with a light roof. It should not be necessary to empty the septic tank often. Still, another important point in septic tank work was mentioned by the author. Again and again, he remarked, one sees works designed with a storm water overflow coming out of the septic tank; this is surely a mistake. Storm water, up to three times the dry weather flow or more, may well flow through the tank on to the beds, but when the limit is reached at which the overflow comes into action, there can be no possible advantage in taking clean water into the septic tank in order to let it overflow. Obviously, the common-sense method is to let it overflow out of the sewer before reaching the septic tank.

The following is from the author's concluding remarks :—

Great scientific authorities appear to differ so strongly on the subject of sewage disposal, that the general public regard the whole question as being in a chaotic state, and this feeling is not removed by the very cautious statements made by the Royal Commission, or by their slowness to express any definite opinion. These differences are surely more of a theoretical than of a practical nature. No doubt we go on learning, but we are no longer in the experimental stage, and we know perfectly well that money spent by local authorities in putting in proper works will not be wasted.

The author feels confident that scientists will agree with him in saying that good engineering and careful attention to the details of construction of new works are absolutely essential if the discoveries of scientists, and the principles laid down, are to have fair play, and that they will welcome a discussion of the purely engineering side of the question, which cannot fail to be of interest alike to the practical and to the theoretical man.

HEATING AND VENTILATING SMALL WORKSHOPS.

At the meeting of the Junior Institution of Engineers, held at the Westminster Palace Hotel, on April 8th, the Chairman, Mr. Samuel Cutler, Junr., M.I.Mech.E., presiding, a paper on "Heating and Ventilating Small Workshops," was read by Mr. Kenneth Gray, M.San.Inst. Employers of labour, he said, are beginning to pay attention to the ventilation and warming of their shops. Experience shows that, apart from the benefit which the employees derive from healthy and comfortable surroundings, a real economy is effected where a large quantity of fresh, warmed air is continually passing through the shops. The breathing of impure air, charged to excess with carbonic acid, and laden with all kinds of animal, vegetable, and mineral impurities, greatly reduces the bodily vigour of the workpeople, and so contributes to slackness.

A close investigation of the changes which take place in air in the process of breathing seems to show that expired breath, although at the moment of leaving the lungs, no doubt tends to rise, yet is probably rapidly cooled, and, being a heavier mixture than fresh air, falls again almost at once. The fact that air at 32° F. is raised through 60° F., although in contact with the lungs for but two or three seconds, shows how rapidly its temperature is changed. And as in breathing out, it is emitted through the nostrils in a downward direction, in two attenuated streams, it seems probable that an equally rapid cooling takes place. Under these circumstances, if the ventilating outlet registers are placed near the floor level, and the fresh air inlets above head level, and some mechanical power is used to drive the air into the shops, a continual stream of fresh air will be passing into the building, while the expired vitiated air is safely carried away through the extraction shafts.

With all systems of ventilation it is necessary to provide means to warm the incoming air, and it seems advisable to do this while it is passing through the main duct leading to the shops. But it is a good plan not to heat the air to a high temperature; there are many reasons why it is advisable to heat it only to the same temperature as that which it is intended to maintain in the shops. The warming of the shops can best be secured by direct heating, *i.e.*, the fixing of the radiating surface inside the various shops. Where appearance is not of such importance as economy of space, this can be effectively done by fixing hot-water or steam pipes above head level. The only difference this makes in warming a building is that it takes rather longer to raise the temperature than when the pipes are fixed on the floor level; but as soon as the required temperature is reached it can be just as easily maintained.

Messrs. W. G. Wernham, Percy Young, J. H. Pearson, A. W. Marshall, T. C. Morewood, R. Marshall, G. T. Bullock, G. C. Allingham, J. N. Boot, J. W. Nisbet, and the Chairman took part in the discussion which followed, and much interest was shown in the relative

ments of mechanical and natural ventilation, and the Plenum and Extraction systems. The next meeting of the Institution takes place on May 8th, when a paper on "The Design of a Dry Dock" will be read by Mr. A. W. Young (Member) of the Admiralty Works Department.

TECHNICAL EDUCATION AT HOME AND ABROAD.

(Concluded.)

TECHNICAL EDUCATION ABROAD.

WITH regard to the manner in which technical education has been viewed and treated in other countries, it may be noted that, in most Continental States, with perhaps the exception of Germany and France, theoretical knowledge has been *too much* in evidence, and while the student of engineering has been well equipped with a large amount of theoretical knowledge, he has very often had little or no practical experience of the machines or designs he has been studying. This state of things is to be deplored, and it is very satisfactory to find now on the Continent as at home, a tendency to the general adoption of laboratories and workshops in all the technical institution to supplement the lectures.

The Engineering Congress held in Paris, 1899, was very unanimous in its opinion of the absolute need of well-equipped laboratories of technical instruction.

GERMANY.

Of the European States Germany perhaps holds a leading position with regard to the development of the education of engineers. One good point in the system there in vogue is that a student must have had some practical experience before he may enter for his first academic examination.

FRANCE.

In France the spirit of development in educational matters has also been very much alive, and schemes by which it has been sought to bring about improvements have been adopted. One such scheme* may be cited here.

In 1882 a school in connection with the Northern Railway of France was founded exclusively for the benefit of the sons of the employees.

Entrance is obtained by competitive examinations held every year under the supervision of the chief engineer. The number of pupils average forty, they enter at from thirteen to fifteen years of age, and take a course of tuition extending over three years. There are no fees and all books and tools are supplied. The subjects taught are: Arithmetic, geometry, geography, French language, physics and chemistry, engine construction and drawing, with a practical training in locomotive work. Periodic examinations are held upon the results of which prizes and certificates are awarded.

Up to the present, about two-thirds of the pupils have been awarded certificates, and have mostly entered the company's service. Some have gone into the employment of other firms, but these have always the privilege of preference over all other candidates should they afterwards wish to re-enter the service of the company.

* "Revue Generale des Chemins de fer," July, 1900.

AMERICA.

In America this subject has received very full attention, and the author thinks that a great deal of the means adopted in the United States could be profitably studied in this country. For some thirty years America has been working out the higher education of engineers, and there is sufficient testimony in her well-equipped colleges that a long-felt want has been supplied.

At Cornell University, for example, there is accommodation for some 2,000 students, who enter on passing an entrance examination of no great difficulty, and continue their studies for four or five years. On leaving at about 22 or 23 years of age, a student is considered to have so developed in his practical and theoretical experience as to be capable of taking the reins of management of not unimportant works.

With reference to the system in vogue in foreign countries there is one very important factor, viz., that the required training may be obtained with much lower fees and less expenditure generally to the student than in Great Britain; which doubtless has had the effect of sending so many British students abroad—especially to Germany—to pass through a course of study for which in this country their means would have been quite inadequate.

SCOTLAND.

In Scotland, however, a more liberal view of this question has been taken than in England; there, a student is able to take a full course for what at the best colleges in England would hardly suffice for one session, and with the additional advantage that in the long vacation, during the summer months, he is usually able—due to the courtesy of the employer—to follow his profession in the shipyards, shops, or drawing office.

There is at the moment a general tendency on all sides to what may be termed a second revival of learning, and it is hoped the present movement may break through that conservatism by which progress—at least in technical matters—has been so long retarded.

COMING EVENTS—MAY.

2nd.—Society of Engineers meet at 7.30 p.m. Cantor Lecture at the Society of Arts.

5th.—The Iron and Steel Institute: Annual Meeting. —Civil and Mechanical Engineers: Society meet at Caxton Hall at 8 p.m.

6th.—The Iron and Steel Institute: Annual Meeting.

7th.—Birmingham Association of Mechanical Engineers.

9th.—Institution of Mechanical Engineers: Graduates' meeting at 7.30 p.m. Cantor Lecture, Society of Arts.

11th.—Birmingham Local Section Institution Electrical Engineers: Visit the University Power Station, followed by Annual General Meeting.

12th.—Institution of Electrical Engineers meet.

14th.—Birmingham Association of Mechanical Engineers: Visit the University Power Station.

16th.—North-East Coast Institution of Engineers and Shipbuilders: Graduates' Section meets at Newcastle.

18th.—North-East Coast Institution of Engineers and Shipbuilders meet.

19th.—Institution of Mining and Metallurgy, 8 p.m.

20th.—City of London College Science Society: Annual Meeting at 7.30 p.m.

22nd.—The International Marine Association: Fourth Congress opens in Lisbon.

24th.—Birmingham University Engineering Society.

26th.—The Leeds Association of Engineers meet at 7.30 p.m.—Institution of Electrical Engineers: Annual General Meeting.

27th.—The Midland Counties Institution of Engineers: "Federated" Meeting.

28th.—The International Marine Association: Fourth Congress closes in Lisbon.

BOOKS OF THE MONTH.

"A MANUAL OF CIVIL ENGINEERING."

By William John Macquorn Rankine, C.E. With numerous diagrams. Charles Griffin and Co., Ltd. 16s.

Professor Rankine's indispensable manual has now reached its twenty-second edition, which has been thoroughly revised by Mr. W. J. Millar, C.E., and has received a number of additions. It is almost unnecessary to remind engineers that, like ancient Gaul, it is divided into three parts, the first dealing with engineering geodesy, or field-work; the second with materials and structures; and the third setting forth under the heading of combined structures, the principles according to which the structures described in the second part are combined into extensive works of engineering, such as roads, railways, river improvements, water-works, canals, sea defences, harbours, etc. In its latest form the volume has 820 pages and about 300 figures.

"PRACTICAL SHIPBUILDING."

A Treatise on the Structural Design and Building of Modern Steel Vessels, the Work of Construction, from the Making of the Raw Material to the Equipped Vessel, including Subsequent Up-keep and Repairs. By A. Campbell Holms. In two volumes. Longmans, Green and Co. 48s. net.

Mr. Holms has done an important service by presenting a complete view of practical shipbuilding in such a manner that it is equally valuable for systematic study or casual reference. While carefully avoiding abstruse problems, he describes succinctly the fundamental theories covering structural design, and here it may be said that in conjunction with the plates which are issued in a separate volume, the subject matter throughout the work can be understood by any intelligent reader. The author then discusses the various stresses to which the hull is exposed, their straining tendency, and the different structural designs by which the necessary strength to resist them may be secured. Each important part of the hull is then considered from three points of view, viz., its purpose in the structure and the particular stresses and straining effects to which it is liable; the various formations adopted in its design, with the rules governing them as regards scantlings and strength; and a description of the actual work of making it in the shipyard and fitting it in the ship. Attention has been given to almost every point that is likely to arise in modern practice, valuable chapters being included on corrosion, launching, etc., and on the work of the drawing office.

"THE 'SHIPPING WORLD' YEAR-BOOK."

A Desk Manual in Trade, Commerce, and Navigation. Edited by Evan Rowland Jones. 1904. Published at the "Shipping World" Office. 5s. in United Kingdom; 6s. in foreign countries.

Our old friend the "'Shipping World' Year Book"—edited by Mr. Evan Rowland Jones—makes its appearance this year with a new map specially prepared by Mr. J. G. Bartholomew, F.R.G.S., showing the Routes of Steamers and Railways throughout the World, with the East Bound and West Bound "Lanes" across the Atlantic, and the Products, Ports, Coaling Stations, Coalfields, etc., of all Countries and Colonies. The inset maps show many of the great shipping centres and waterways of the world.

The additions made in the present edition of the "Year Book" embrace: The New Tariffs of the South African Customs Union, Australia, China, Japan; Turkey, the Philippines, Venezuela, and other countries, the separation of foreign Tariffs formerly embraced in the composite section; and the correction of all; the new Admiralty Regulations for the training of Naval Officers; a list of the Customs Boarding Stations; New Board of Trade Rules governing Shelter-decked Steamers, Deck Cargoes, Certificates of Discharge and Character, Naturalisation, etc.; Customs regulations governing the Export (Coal) Duty Act, 1901, and a Table giving the Steam Tonnage of all nations of twelve knots and upwards. In this eighteenth edition are also included: the Amendment Act of August 6th, 1900, giving the reciprocal obligations of dock, canal, and harbour authorities on the one hand and shipowners on the other; the International Code of Signals (illustrated); returns for the year ended December 31st, 1903, of Vessels built and building for the World's Navies, of the output of British, Colonial, and Foreign merchantmen, of the World's Tonnage engaged in the Foreign and Coasting Trades, and of our Imports and Exports; and the addition of every known port not hitherto included in the Port Directories; together with the Board of Trade Regulations governing the loading of turret-deck vessels, and for Preventing Collisions at Sea; the new Departmental Orders governing the Surrender of Deserters Abroad, the Carriage of Grain Act, and all other important Regulations affecting Shipping, now operative. All the regular features have been brought up to date, and the publication well maintains its reputation as a carefully edited and efficient reference work.

"CYANIDING GOLD AND SILVER ORES."

A Practical Treatise on the Cyanide Process; embracing Technical and Commercial Investigations, the Chemistry in Theory and Practice, Methods of working and the Costs, Design and Construction of the Plant and the Costs. By H. Forbes Julian and Edgar Smart, A.M.Inst.C.E. Charles Griffin and Co., Ltd. 21s. net.

This very complete work brings together in a single volume a mass of data which should be invaluable to the engineer. The authors have chiefly concerned themselves with the principles involved in working the process and in the construction of plants. In cyanide practice the importance of a thorough knowledge of theoretical principles is too obvious to need emphasis, and that these are clearly explained will be understood by the readers of PAGE'S MAGAZINE who are already familiar with Mr. Smart's lucid and informing style. The work is of an essentially practical type, in which much attention has been given to the important question of costs. The formulæ and rules are, for the most part, deduced from practice. Constants are used which may be adjusted to meet abnormal conditions, and thus the formulæ can be universally applied. Copious tables are given, as the best means of simplifying calculations and of expressing results for practical men. The working drawings also have been largely used in actual practice. The forty-four chapters comprised in the work are illustrated by 191 figures, including some thirty-five folding plates. The authors are to be congratulated upon the production of what should prove to be a standard work.

"BRITISH RAILWAYS."

Their Organisation and Management. By Hugh Munro Ross, B.A. Edward Arnold. 5s. net.

We recommend this book to the attention of those who are seeking general information about our British Railways; the author does not profess to deal in technicalities. The work is concerned rather with questions of organisation and administration; the author takes us behind the scenes and tells us how things are worked. For instance, a time table to the ordinary passenger seems so simple as to require no explanation. The author shows in a most interesting way how the time tables are made up, and how the traffic manager of an ordinary trunk line contrives to make a single pair of rails accommodate trains of all speeds from expresses timed to run at forty-five miles an hour, down to heavy mineral trains travelling at only one quarter that rate. He has also much of interest to say upon such subjects as train miles and ton miles, the carriage of passengers, goods rates, rate legislation of 1891 and 1892, capital, expenses, and dividends. With regard to the future, it is remarked that the railways may fairly regard the prices they paid for fuel in 1900 and 1901 as abnormal; but they need not look forward to any reduction in wages, or to any general increase in their rates for carrying passengers and goods. Their hope must rather be in greater economy of operation. Not much space is devoted to the subject of electrical conversion, but the author considers that for the present electrical traction for long distance express trains and the heavy goods traffic are scarcely within the range of practical railway politics; and many difficult questions, both financial and engineering, will have to be answered before the steam locomotive finally disappears from our main trunk lines.

"WORK."

The Illustrated Weekly Journal for Mechanics. Vol. XXVI. from August 8th, 1903, to January 30th, 1904. Cassell and Co., Ltd.

Volume XXVI. of "Work" is, as usual, replete with information and drawings interesting to mechanics, the frontispiece being a coloured supplement illustrating a fretsaw for lathe with vertical movement and tilting table. The other coloured supplements are chiefly concerned with the construction of domestic furniture. The index shows a very wide range of subject, from acetylene generators to an ice yacht.

"MODERN ELECTRIC PRACTICE."

Edited by Magnus Maclean, M.A., D.Sc. Vols. I. and II. The Gresham Publishing Co. 9s. net each.

Professor Maclean has gone to work on the assumption that no comprehensive treatise on modern electric practice, suitable alike for students and practical engineers, can be produced by a single writer. He has accordingly sought the aid of more than thirty technical men, each of whom will contribute his specialised share to the six large volumes, which will comprise the work. This co-operation on the part of a number of writers will necessarily involve a certain amount of overlapping, but the author deserves considerable credit for the manner in which, judging by the two volumes which are before us, and the outline of the treatise contained in the first volume, he has welded these contributions into a harmonious whole. The volumes, both as regards illustrations, printing, and cover, have a highly-artistic finish, somewhat rare in technical works.

The treatise will be divided into five sections, as follows: (1) the Measuring, Generating, Transforming and Storing of Electric Currents; (2) Electric Lighting and Electric Power Distribution; (3) Electric Tramways; (4) Boilers and Prime Movers; (5) Miscellaneous Applications of Electricity. In Volume I. under Section 1—the Measuring, Generating, Transforming, and Storing of Electric Currents—will be found the following contributions: (1) Electric and Magnetic Measurements, by Alfred Hay, D.Sc., M.I.E.E. (2) Alternating-Current Measurements, by E. W. Marchant, D.Sc., M.I.E.E.; (3) Continuous-Current Generators, by W. C. Mountain and J. Leggat; (4) Alternating-Current Gererators, by E. J. Berg; and (5) The Continuous-Current Motor, by A. T. Snell, C.E., A.M.Inst.C.E., M.I.E.E.

Vol. II. has the completion of Section 1, as follows:—

(6) Alternating-Current Motors, by M. B. Field, M.I.E.E., A.M.Inst.C.E., and G. G. Braid, A.M.Inst.C.E. (7) Static Transformers and Rotary Converters, by A. F. Berry; and (8) Electric Storage Batteries by J. T. Niblett, M.I.E.E. In this volume the section of Electric Lighting and Power Distribution is commenced, Mr. W. E. Warrilow being responsible for (1) Switches and Switch-Gear, and Mr. J. C. A. Ward, A.M.I.E.E., for (2) Electric Mains.

"WHO'S WHO. 1904."

A. and C. Black. 7s. 6d. net.

If size be a criterion of success, "Who's Who for 1904" has made a marked advance. The tables which formed the first part of this vade mecum of identification have been ousted from the parent book this year, and form a separate work, which has received the name of the "Who's Who Year-Book." 1s. net. Despite this excision, "Who's Who" seems to lose nothing in bulk, and it certainly does not lose in interest. We have on many occasions put "Who's Who" to the practical test, and have often admired the way in which the editor carries out his very difficult task. "Who's Who?" is not an easy question to grapple with, but the volume under consideration answers it in nine cases out of ten with accuracy and efficiency.

From the same publishers we have also received a copy of "The Englishwoman's Year-Book for 1904," which well maintains its standard of usefulness, and has, among other features, a quantity of information on technical education, scholarships, etc.

LOCKWOOD'S BUILDER'S, ARCHITECT'S, CONTRACTOR'S, AND ENGINEER'S PRICE BOOK FOR 1904.

A Comprehensive Handbook of the latest prices of every kind of material and labour in trades connected with building, including many useful memoranda and tables, with a supplement containing the London Building Acts, 1894 and 1898, and other enactments relating to buildings in the Metropolis with the By-laws and other Regulations now in force. Notes of all important decisions in the Superior Courts, and an index to the acts and regulations. Edited by Francis T. W. Miller. Crosby, Lockwood and Son. 4s.

In the 1904 edition, special attention has been given to the distinctive features of modern building—such as sanitary appliances in their latest forms, improved methods of ventilation, lighting, etc.—as well as to new forms of materials. The work generally has been brought up to date and well maintains its reputation as an office auxiliary of the first class.

We are compelled to hold over a number of book notices owing to pressure upon our space.—[Ed.]

OUR DIARY.

March.

22nd.—Launch of the twin-screw steamer *Antrim*.—At a meeting of Leeds citizens it is announced that £39,938 has been subscribed towards the £100,000 which must be raised before the projected university obtains the sanction of the Privy Council.

23rd.—Opening of the spring meeting of the Institution of Naval Architects at the Society of Arts. It is reported that there will be an increase of over £600,000 in the New Zealand Revenue.

24th.—The Cunard Company decide to adopt turbine engines in the new fast steamships which are to be built under their agreement with the Government.

25th.—The Institution of Naval Architects conclude their spring meeting.

26th.—The G.P.O. announce the extension of telephonic communication between a number of provincial towns in England and France.—A Hyde Park demonstration protests against the importation of indentured Chinese labour into the Transvaal.

28th.—The Lord Mayor formally opens the widened footways of London Bridge.—An initial journey of inspection made over the London United Tramways company's new line from Southall to Uxbridge.

29th.—Opening of the Transvaal Technical Institute—the nucleus of the future university at Johannesburg.—The North-Eastern Railway Company open electric train service on their Newcastle surburban lines.

30th.—Launch at Hebburn-on-Tyne of the *Turbinia*—the first turbine passenger steamer for service on the Canadian lakes.

31st.—Our total revenue receipts for the year ending to-day are £151,212,409.—The Goldsmiths' Company make a subvention of £1,000 to the Royal Society to constitute a radium research fund.—Launch of the twin-screw steamer *Dunluce Castle* at Queen's Island.—The new lighthouse at Dungeness is brought into use.

April.

1st.—The South Australian revenue return for the past nine months amounts to £1,785,850.

2nd.—A meeting of the Northumberland Coal Conciliation Board agrees upon a reduction of 2½ per cent. off the miners' wages.

5th.—It is announced that Lieut.-Colonel R. E. B. Crompton, C.B., has been granted the honorary rank of major on relinquishing his temporary commission for service in South Africa.—Death of Mr. J. S. Forbes, the chairman and director of the London, Chatham and Dover Railway.

6th.—Lord Kelvin is elected Chancellor of the Glasgow University.

7th.—The trustees of the Swansea Harbour accept the tender of Messrs. Topham, Jones and Railton, Westminster, for the construction of new docks.

8th.—The document embodying the Anglo-French Agreement is signed at the Foreign Office by representatives of the two Governments.

9th.—The New Zealand Annual Congress of Trade Council delegates resolve to urge the Government to establish ironworks and shipbuilding yards, and to nationalise the marine, coastal, and inter-colonial services.

10th.—Death of Colonel John Stevenson.

11th.—A representative conference of miners of the United Kingdom meet under the presidency of Mr. Enoch Edwards to appoint a deputation to the Chancellor of the Exchequer with a view to the abolition of the coal tax.

12th.—Issue of a Parliamentary paper containing the text of the Agreement between Great Britain and France.—Publication of Lord Cromer's annual report on the condition of Egypt and the Soudan.—The Chancellor of the Exchequer receives a deputation of coal-owners, exporters, miners, etc., who urge the repeal of the export duty on coal.—Telephone service opens between provincial towns in England and France.

14th.—Counsel on behalf of the City Corporation formally intimates the withdrawal of the Bill for the reconstruction of Southwark Bridge.

15th.—A Parliamentary committee rejects the East London and Lower Thames Electric Power Bill.

18th.—Submarine A1, which was sunk by collision a month ago, is successfully raised and docked.—The *Times* Johannesburg correspondent deprecates further delay in putting the Labour Ordinance into effect as being prejudicial to the mining industry and probably causing difficulties in the Chinese recruiting districts.

19th.—Death of Sir Clement Le Neve Foster.—Launch at Barrow of the *Sentinel*, the first war vessel of the new *Scout* class.—Launch of a steamer for direct West Indian service at Govan.—A destructive fire breaks out at Toronto.

20th.—Sir W. White and others interested in the production of steel visit Hadfield's Steel Foundry, Sheffield.—The Toronto fire is subdued—property destroyed covered an area of 30,000 acres; the total loss is estimated at £2,000,000.

NEW CATALOGUES AND TRADE PUBLICATIONS.

Simplex Steel Conduit Company, Ltd., send an embossed trade mark show card. It is a bold and striking design suitable for hanging on the wall.

Alfred Dodman and Co., Ltd., forward a picture postcard, showing a consignment of their Cornish boilers leaving for South Africa, January 6th, 1904.

Allgemeine Elektricitats - Gesellschaft und Union-Elektricitats-Gesellschaft.—An interesting pamphlet on electric locomotives, in which full advantage is taken of the best half-tone work.

Walker Bros., Ltd., Victoria Iron Works, Walsall, are issuing a series of large postcards with details of their specialities. The one before us gives a complete list of rolled steel joists.

The Lahmeyer Electrical Company, Ltd.—List No. 13 B gives full details of their controllers and other apparatus employed for electrically-driven cranes, hoists, lifts, and other variable speed machines.

The British Thomson-Houston Company, Ltd.—Pamphlets Nos. 105 and 106 deal respectively with open arc lamps and electro-magnetic track brakes, and are perforated ready for filing on the firm's cumulative catalogue.

Bath Electric Manufacturing Company, Ltd., forward Pamphlet No. 15, descriptive of their "Kramos" Resistance Piece, which is described as an electro-ceramic product, quite original in its composition, structure and methods of production.

The Anglo-American Machine Tool Company, Ltd.—From this firm we have received an engineer's sketching-pad for making drawings to scale. The price is stated at 6d. net, but as the specialities of the firm are largely in evidence, we presume that this is nominal only. It is neatly produced and should find a wide use.

The Metallic Paint Company, Ltd., of Cardiff, send us a sample of their Moreton's E.G. solution—a metallic paint for coating iron and woodwork, also cylinder tops and engine-room fittings, etc. It is claimed for this paint that it is unaffected by heat (up to 400 deg. F.), salt water spray, atmospheric or climatic conditions. The tint is a bright silver.

S. Howes and Co. (L. E. Barbeau, President).—The list of wheat and seed cleaning apparatus, issued January, 1904, supersedes all previous issues. We are reminded that catalogues are furnished in French, Spanish, German, Italian or English, upon application, for agricultural, bakers', barley, blacksmiths', canning, coffee, confectionery, corn (maize) milling, cotton, flour mill, malt, oatmeal, rice, seed, and wheat cleaning machinery, rams, pumps and turbines.

W. H. Willcox and Co., Ltd.—The latest booklet published by this firm illustrates various motor engineers' specialities exhibited at the recent Automobile Exhibition at the Crystal Palace. It is of special interest to motor-car manufacturers and includes details of lubricating oils, semi-rotary water-circulating pumps, Penberthy patent automobile-injectors, X-L water raisers, patent wire-bound hose, "Richardson" boiler feed pump, lubricators, oil cans, lifting jacks, belting, spanners, pliers, tool kits and tools of every description.

Graham, Morton and Co.—From this firm we have received an attractively-printed souvenir of the visit of inspection paid to the new engineering works which have been described in PAGE'S MAGAZINE. H.R.H. the Prince of Wales recently accepted a copy of the souvenir and at the same time congratulated Mr. Maurice Graham, the managing director, on the great rapidity with which the undertaking was carried out. This firm seems to be one of the first to follow the dictum of His Royal Highness, given on September 5th, 1901, that the old country must wake up. The souvenir before us presents a capital object lesson in efficient organisation.

Fleming, Birkby and Goodall, Ltd.—The new catalogue of this firm's specialities is divided as follows: Leather beltings; textile beltings; belt fasteners and stretchers; picking bands, pickers, hydraulic leathers, leather and canvas hose; India rubber goods, hard fibre, gutta percha, ebonite, steam packings, etc.; Gilbert wood pulleys, wrought iron pulleys, metallic tubing, and sundries; card clothing, silk combs, etc. Section H is devoted to useful hints on leather belting, rules, mechanical data, and other special and general information on commercial matters. Everything has obviously been done to make the catalogue complete, and its arrangement leaves nothing to be desired.

The British Westinghouse Electric and Manufacturing Company, Ltd.—Special Publication No. 7,002 (Second Edition), is an interesting account of the Washington, Baltimore and Annapolis Single Phase Railway, by Mr. B. G. Lamme, being a paper presented at the 168th meeting of the American Institute of Electrical Engineers, New York, September 26th, 1902. Special Publication, No. 7,004 (Second Edition), is Mr. N. W. Storer's description of the operation of variable speed D.C. motors on the three-wire system. Another publication received from this company is a reprint of the Report of the Board appointed to inquire into the efficiency of turbine engines; it is reprinted from the "Journal of the American Society of Naval Engineers."

Horsfall Destructor Company, Ltd.—List No. 1 of Horsfall Destructors has a collection of instructive illustrations showing the numerous plants erected by the company at home and abroad, from Accrington to Zurich. Page 85 brings us to the Horsfall Destructor on the Bullerdeich, at Hamburg—the largest destructor in the world. This was erected in 1895, and has thirty-six cells of the Horsfall standard back-to-back top-feed type. At the end of the catalogue will be found details of the Horsfall patent hospital destructor, portable destructor, centrifugal dustcatcher, furnace for recovering solder, clinker railway, clinker crushing mills, and mortar mills, all being specialities of the company. List No. 2 comprises reports and certificates.

Crompton and Co., Ltd.—From this firm we have received a copy of the second edition of their Potentiometer pamphlet, a price list of testing-room appliances, and a brief description of their electrical pyrometers. The Crompton pyrometer is designed for the continuous indication of the temperature of flue gases, of superheated steam, and of similar parts of steam plants, not exceeding 950 deg. F. or 500 deg. C. It has been adopted in many of the principal electric lighting and power stations in England as the standard instrument for verifying apparatus of all kinds, and of measuring the output of the machines and station, and has been supplied to various important technical colleges and laboratories as a part of their equipment.

LIXIVIATION PLANT AT THE PATARA MINES.
(Described by Mr. F. J. Schafer in his article "The Way into Peru.")

A general view, showing how the mountain side has been utilised for obtaining the necessary gravitation. The process offers no unusual features, but the plant is remarkable for the fact that it was entirely constructed by Mr. Schafer, with the aid of Cholas or Indians. The materials were carried on the backs of animals from the coast, and the author had to teach the natives even such simple operations as laying bricks and stoking the boiler.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining and Allied Industries.

Vol. IV. LONDON, JUNE, 1904. No. 6.

ANIMAL TRANSPORT.

The ore is being brought in by mule and donkey transport to the lixiviation plant. Llamas are also extensively used for transport (see page 487), and carry loads up to but not exceeding 100 lb.

THE WAY INTO PERU.

BY

F. J. SCHAFER.

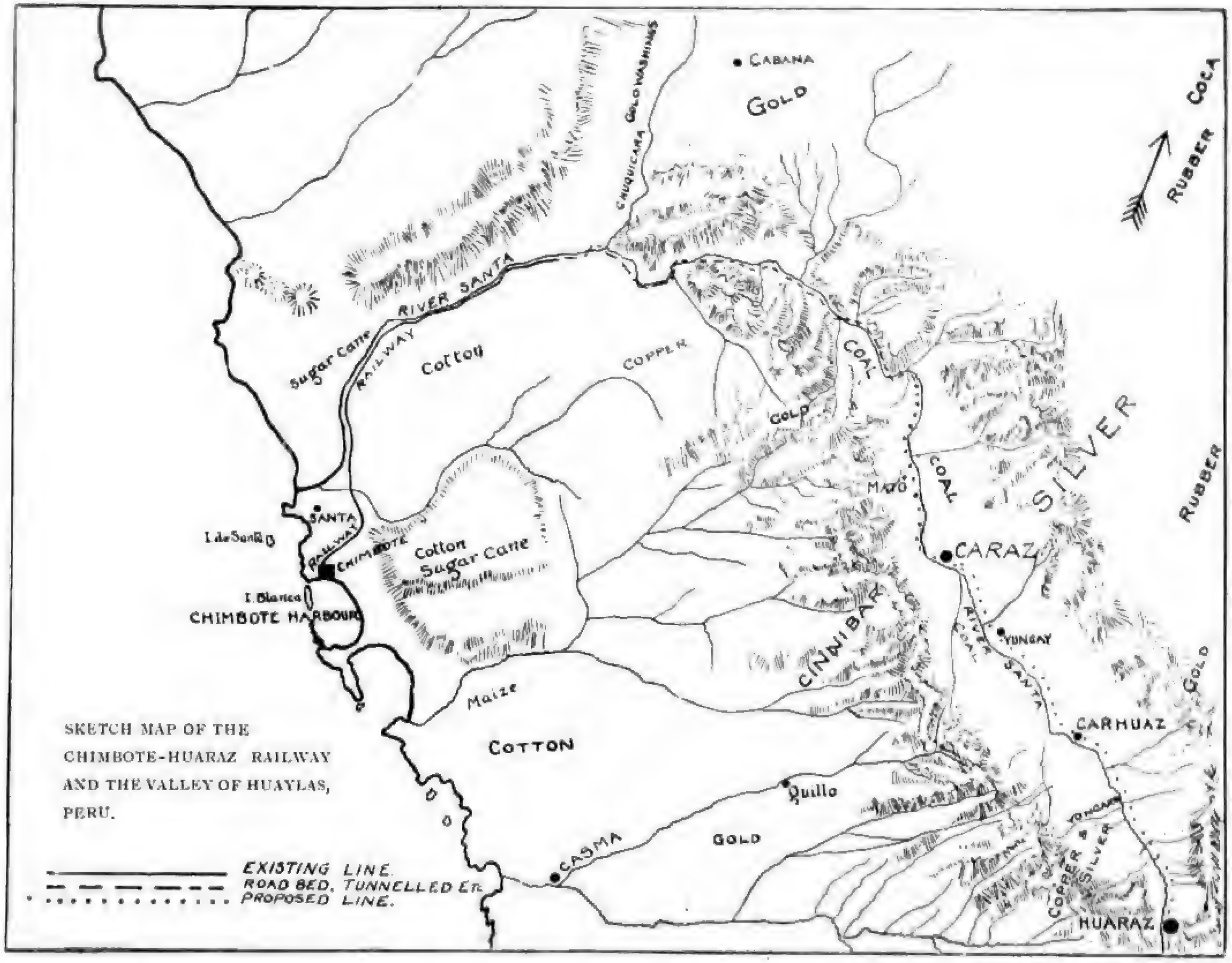
The author describes a very important project for opening up one of the richest and most fertile districts of Peru. He shows that the one thing needful in Peru is an extension of the very limited means of transport. The difficulties which this mountainous country presents to the civil engineer will be realised when it is stated that the Oroya line already existing from Lima, the capital, to Cerro de Pasco, reaches an altitude of 15,650 ft. in a distance of 110 miles. Mr. Schafer proposes to avail himself of the natural route which has been cut out by the River Santa, and also of the preliminary work for the new line carried out by the late Mr. Henry Meiggs. The railway already runs from Chimbote to Suchiman, a distance of thirty-two miles. Mr. Schafer's project provides for the extension of this line to Huaraz, a distance of 160 miles, opening up the rich valley of Huaylas and eventually the enormous rubber tracts which lie beyond.—Ed.

BEFORE leaving office last July, President Romana, in his message to Congress, said:—

"A concession has been granted by my Government for the construction of a railway from the Port of Chimbote to the town of Recuay.

This railway is destined to develop the immense wealth of Peru's most privileged region, that is the Huaylas Valley."

This news was received with enthusiasm, as the construction of this important line will develop Peru enormously.



SKETCH MAP OF THE CHIMBOTE-HUARAZ RAILWAY AND THE VALLEY OF HUAYLAS, PERU.

THE BAY OF CHIMBOTE—A PANORAMIC VIEW.

It will be noticed that the bay is land-locked on the left. The main entrance to the harbour lies to the south-west. In the centre of the picture is seen the island Blanca; to the right are fishermen's huts. The bay of Chimbote is six miles long by four miles wide.

THE PORT OF CHIMBOTE.

This almost land-locked harbour is one of the best deep-water bays on the coast of Peru. It is six miles long, and four miles wide. There is not a rock in the bay. H.M.S. *Egeria* thoroughly surveyed the bay in 1897, and the British Admiralty Chart shows it to be extremely well protected from the west and the prevailing winds of the south. The largest vessels afloat can find safe anchorage in all portions of the bay to within 500 yards of the beach.

The United States Government carried on negotiations with the idea of securing Chimbote as a coaling station, during President Garfield's administration, and since the construction of the Panama Canal has been assured negotiations have been re-opened. Its central position in regard to the principal ports on the west coast of South America is evident when we see that it is situated about 1,300 miles south of Panama and 1,600 miles north of Valparaiso, and about 200 miles north of Callao. The geographical position of Chimbote is about 10 deg. south of the equator.

CHIMBOTE TOWN AND RAILWAY.

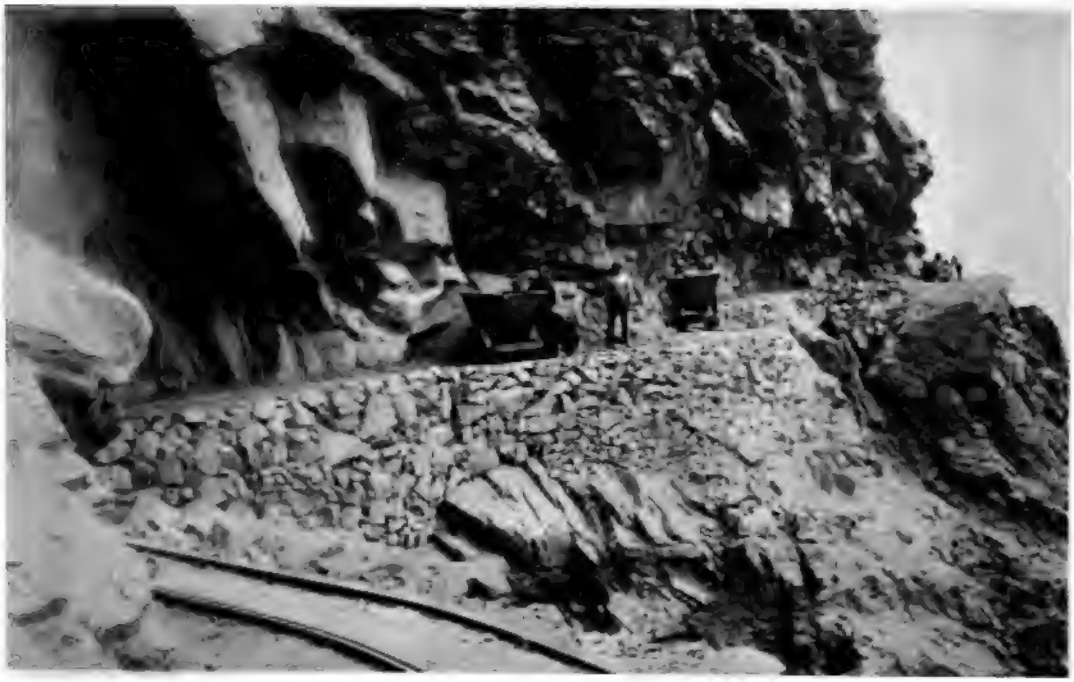
During the boom times, 1872-3, before the Peruvian-Chilian war, Mr. Henry Meiggs undertook the construction of a railway for the Peruvian Government from Chimbote to Huaraz, the capital of Peru's richest province, Ancachs.

It was found that this route was the only one in Peru by which the important mountain towns of Caraz, Yungay, and Huaraz could be reached by a railway of reasonable grades, and by which the summit of the Andes could be reached without repeating the expensive zig-zag Oroya or Central Railroad which in 110 miles climbs to an altitude of 15,650 ft., or about three miles.

Mr. Meiggs planned and laid out a town site on American ideas, and constructed about 80 miles of the proposed line, placed four bridges, completed seven tunnels, ranging from 150 ft. to 600 ft. long, and laid the metals over a distance of 60 miles.

Then the Chilian war broke out. The Chilians took possession of Chimbote, removed locomotives, bridges, and enormous quantities of supplies, and tools to Chili, including the entire outfit of the railway repair shops, which were at the time the best equipped on the west coast of South America.

This disastrous war left Peru in a position absolutely unable to complete this important railway, and moreover, the Government was



TRAMWAY LEADING TO THE GOLD MINES OF THE MACATE GOLD MINING COMPANY.

These mines are situated about 10,000 ft. above sea-level, and are seventy miles distant from Chimbote. The ore is conveyed to the top of an aerial ropeway, by which it is transported to the mill on the River Santa 7,000 ft. below.

forced to make terms with its foreign creditors by handing over to the present Peruvian Corporation all its railways, guano deposits, and other valuable concessions.

During the fifteen years that the Peruvian Corporation has been in possession nothing has been done regarding the prolongation of the Chimbote Railway, and the rights of the Corporation to build the line lapsed.

The Government then arranged with the author and gave him a concession to carry out this important enterprise. Proprietorship in perpetuity is given, and the concessionaire is granted the use of all the material, road bed, bridges, tunnels, etc., constructed by Meiggs; all of this work is estimated to be worth £500,000. The matter is being taken up by an English syndicate, and it is to be hoped that it will remain in British hands.

COAL RESOURCES.

The chief feature of the railway is that within 63 miles from the port and at an altitude of about 2,400 ft. above the sea level, the railway enters the carboniferous Santa Valley region. The best Lancashire coal experts have reported these coal beds, which extend for a distance of 40 miles along both banks of the River Santa to be inexhaustible. It is estimated that over 500,000 tons of coal are consumed along the west coast of South America per year, and nearly all this coal comes from Australia or England. Does it not appear strange that, having abundant supplies within 63 miles of one of its best ports, Peru should be using coal which has to be carried for a distance of from 7,000 to 10,000 miles? The only explanation is that Peru, in consequence of the disastrous war with Chile, was unable to complete this important work, and it is only within the past two years that new investments have been made. Therefore this rich country has lain dormant for all these years.

COPPER.

Certain it is that Peru offers a virgin field for enterprise and capital, its natural resources being enormous. The Americans are beginning to find this out. They have already secured the famous Cerro de Pasco copper mines, which have been worked for 200 years for silver and which some of the best-known English and American mining engineers estimate to contain over 25,000,000 tons of copper ore, carrying 10 per cent. copper, besides considerable silver

METHODS OF TRANSPORT, OLD AND NEW.

The top view shows Bridge No. 4 over the River Santa, on the lower portion of the line already graded. The other view shows a group of llamas used for transport.

PRESENT TERMINUS OF THE LINE FROM CHIMBOTE.

This picture shows on the right the Suchiman Sugar Mill, distant thirty-two miles from Chimbote. On the left is an hotel, near the door being a truck laden with sugar cane. The windmill is used for raising water for the loco tank. In the middle distance is the River Santa.

values. This enterprising American company, which is called the Haggin-Vanderbildt syndicate, paid £700,000 in cash for the mines.

Having just completed 80 miles of standard gauge railway to conne t these mines with the main or central railway of Peru, they are erecting a plant to smelt 1,000 tons of ore per day, and already nearly £2,000,000 in cash have been actually expended. The enterprise involved will be more readily understood when it is stated that these mines are situated at an altitude of over 14,000 ft. above sea level, and that the central railway of Peru reaches a height of 15,600 ft. within 110 miles from the coast.

THE PERUVIAN PEOPLE.

The Peruvian individual business man is always well educated; he generally speaks English and French, in addition to his own language, and during the writer's residence of upwards of ten years among the people of Peru, he has found them to be gentlemanly and upright men, who may be relied upon to meet their obligations. By comparison with the North American and Mexican it can be safely said that they are in every way, whether as a Government or as a people, equal and probably better people to do business with.

THE CLIMATE OF PERU.

The climate varies with the altitude. On the coast and at Chimbote it is hot and very dry, being situated in the rainless zone, and this is one of the reasons why such enormous crops are obtained from sugar-cane, cotton, and rice. Green and ripe cane is seen in the same field, the Indians cutting ripe yellow cane for the mills at one end and the new young green cane growing at the other end of the field. The sugar haciendas around Chimbote are watered by ditches from the Santa River. Peruvian sugar fetches from 1s. to 1s. 6d. per cwt. more than beet sugar, and 3d. per cwt. more than the best Java.

The road bed of the proposed Chimbote Railway rises by a gradual ascent until at a distance of 63 miles one reaches the coal mines at an altitude of 2,400 feet above sea level. Here the climate changes, and from November to April occasional downpours of rain can be expected, whilst the rest of the year is completely dry. Higher up the valley, at a distance of 100 miles and about 5,000 ft. above sea level, the year is divided into two distinct seasons. During the period between May and December (absolutely rainless), the weather resembles that of a beautiful English summer, while between December and May there is rain nearly every day after twelve o'clock. The temperature at from 5,000 ft. to 7,000 ft. above sea level is nearly always about 70 deg. F. At an altitude of 10,000 ft. one has the most delightful climate in the world, with cool, bright sunshine, and very healthy conditions generally, and an average temperature of about 60 deg.

The country at this altitude, and in fact from 3,000 ft. to 12,000 ft., is prolific in agricultural produce. From the sugar cane and the cotton of the coast one passes on to the vineyards, orange, banana, lemon, chirimoya, and other fruit farms of the valleys, 2,000 ft. to 6,000 ft. above sea level, then to the alfalfa fields, peas, beans, sweet potatoes, and yucas, at 7,000 ft. to 10,000 ft., thence to the wheat, barley, oats, and potatoes at from 10,000 ft. to 12,000 ft., then to the natural grazing grounds, the Sierra Pasto, at an altitude of from 12,000 ft. to 15,000 ft., where huge flocks of sheep, cattle, and llamas graze and thrive.

The writer spent three years at the celebrated Patara Mines, situated in this beautiful department of Ancachs. The mine house was at an altitude of 15,800 ft. above sea level, with enormous snow-clad peaks towering on every side, yet there was no permanent snow; the perpetual snow level commences at 16,500 ft.

A NATIVE GIRL EMPLOYED AT THE PATARA MINES.

WEIGHING THE SILVER AS IT LEAVES THE MINES.

These mines are situated at an altitude of 15,600 ft. above sea-level, and are about eighty miles from the coast. This view is taken at a point known to the Indians as Rumi Chaca (Stone Bridge). The bags contain rich, selected ore, while the boxes are filled with silver sulphide (about 70 per cent. silver) the product of the lixiviation process. The grinding mill seen on the right is driven by a Pelton wheel.

MR. SCHAFER (MANAGER) AND THE STAFF AT THE PATARA MINES.

On the extreme left of the picture is the manager of the commissariat department. At his elbow is the book-keeper ; while on the other side of Mr. Schafer are the chemist (Dr. Hanson), the mine boss, and on the extreme right Mr. F. Scott, assistant assayer. In the front row, from left to right, are the assistant mine manager, the cashier, the transport manager ; and, on the right, Señor Menesis, the only engineer Mr. Schafer was able to obtain as an assistant after the plant was built.

GROUP OF NATIVE SERVANTS.

Labour in Peru is very cheap, and consequently the above may be taken to represent the ordinary household retinue of a mine manager. In the centre of the group (holding frying-pan) is the Chinese cook. The Cholas, or Indians, are wearing ponchos, which may be described roughly as a big blanket with a hole in the centre, ready to be thrown over the shoulders. The author describes the natives as a moral people. Though not particularly clean, they are extremely intelligent, and make good servants.

The temperature was constantly just below freezing, yet in four hours on a good mule he was able to descend from snow and ice through beautiful fields of alfalfa, grazing land, fruit farms and vineyards, to the tropical heat of the sugar plantations.

THE VALLEY OF HUAYLAS.

The proposed Chimbote Railway, starting at sea level reaches the summit of the Cordillera of the Andes at Huaraz, the capital of the province of Ancachs. It passes through the sugar cane and cotton haciendas of the coast, then following the sinuous windings of the River Santa, which is the largest in Peru that flows into the Pacific Ocean, it passes through the coal region at 63 miles from the coast.

The following is an analysis of the coals which are here found in large beds of from 3 ft. to 10 ft. wide, and at less than 2,400 ft. above sea level :—

	Anthracite.	Bituminous.
Fixed carbon ...	86·58 per cent. ...	64·80 per cent.
Volatile matter ...	3·77 ,, ...	21·00 ,,
Ash	3·83 ,, ...	5·20 ,,
Moisture ...	4·96 ,, ...	8·30 ,,
Sulphur	0·86 ,, ...	0·70 ,,

Some 30 miles higher up the railway enters the beautiful callejon or Valley of Huaylas, at Mato, a small town at the foot of the Black Cordillera. Here the valley widens out, and a more picturesque scene it would be difficult to find in any part of the world. On the right bank the white or snow-capped Andes stretch as far as the eye can see, whilst on the left rise the beautiful Cordillera Negra, so-called because although in parts quite as high as the white Andes, these mountains are not snow-capped. The slopes of both these immense ranges are cultivated with wheat, barley and other products, whilst the valley itself is planted with cane, fruit trees, and alfalfa. Through the centre winds the Santa River, and the picture from a height of 10,000 ft. to 12,000 ft. is superb. Varying in width from one to four miles and continuing on a gradual up grade of about 2 per cent. to Huaraz, which is 12,000 ft. above sea level, the valley is densely populated by an industrious and thrifty people, who are the descendants of the Inca race.

It is estimated that the railway will serve a population of from 600,000 to 700,000. The chief towns are Caraz, Yungay, Carhuaz, and

has been reached the descent on the Eastern slope becomes an easy matter, and this leads us to the Montaña, to thousands upon thousands of acres of indiarubber of the finest kind, within easy each of either the proposed railway or a navigable point on the Marañon, or head waters of the Amazon River.

Andrew Carnegie is quoted as having said: "If I had to work my way again in the world, I would not go back to the iron and steel industry, but would take up the indiarubber industry, in which a man of very little means can soon make a fortune."

Once on the eastern slope one is in a country well watered by immense rivers, there are over 6,000 miles of continuous internal navigation. Professor Orton says of this country: "Peru has immense capabilities. She is the France of South America. All the fruits and grains of the earth find a congenial and fertile soil here, with the Pacific on the left and the navigable Amazon on the right, with mountains of mineral wealth untouched, with highland valleys, like the over-hanging gardens of Babylon for beauty, and with plains and reclaimable pampas, which might equal Egypt in fertility, Peru is potentially one of the richest countries of the globe." No other country can furnish 6,000 miles of continuous internal navigation for large steamers. For 2,000 miles from its mouth, the Amazon stream has no less than seven fathoms of water and not a fall interrupts navigation for 2,600 miles. What is to become of this great region? The wealth of an empire is yearly lost in the rubber forests alone. The soil can be had for practically nothing, and when one sees this enormous over-abundance of stagnant wealth, one asks oneself by what strange fatality half the world is covered with inhabitants so that there is not enough bread for all, whilst in the other half the population is so small that there are not enough hands to gather the harvests.

The solution to this question is the building of such railways as the Chimbote-Huaraz line, and then we will enable Humbolt's saying to become truth, namely: "Here in Peru, sooner or later, the civilisation of the world will be centred."

Señor Alejandro Garland, the well-known political economist, in a very able article on the Railroads of Peru, published in the Lima "Comercio," March 27th, 1904, says:—

"Whenever Peru's financial position improves a distinct tendency is exhibited towards the construction of railways, and among other proposals the one to construct a line running along the coast has been extensively discussed.

"For my part, I am diametrically opposed to any coast railways whatever, and I consider we would be committing a very grave error in devoting the £200,000 which the new Tobacco Tax will produce annually for such a purpose, for the following reasons:—

"The remarkable calm of the Pacific Ocean which washes our coast, and the complete absence of storms, together with the excellence of the majority of the ports, make the establishment of a maritime traffic on a very economical basis an easy matter. On the other hand, it would be difficult to exaggerate the manifold advantages which railways running from west to east, or from our coasts into the interior of Peru would afford.

"For example, what an enormous gain it would be to Peru if the Chimbote Railway were extended even for only the forty odd miles which are still needed to reach the important carboniferous region of that valley, from which excellent coal can be extracted and delivered in one of the most beautiful harbours of our coast at a maximum cost of £1 per ton to the consumer.

"Such are the enterprises which Peru should encourage in order to insure her progress. It is inadmissible in the present condition of the country to use the funds at our disposal in supplanting the existing maritime communication by coast railways."

A LECTURE BY PROF. WORTHINGTON, C.B., F.R.S.

FAMOUS TECHNICAL INSTITUTIONS.

IV.—The Royal Naval Engineering College, Keyham.

BY

C. ALFRED SMITH, B.Sc., A.M.I.E.E. (late R.N.).

In this article the author describes the course of training which has been in vogue for the last fifteen years, and which he himself has passed through. Under the new regulations, Keyham College will still be used as a training institution for engineer officers during the last three years of their training. For the excellent series of illustrations we are chiefly indebted to "The King and his Navy and Army."—Ed.

It is an axiom with the British public that the security of our commerce and the safety of our Empire depend entirely upon the efficiency of the Royal Navy. But what the public do not fully appreciate is the fact, patent to all the technical readers of this journal, that the efficiency of the Royal Navy as a fighting machine is very largely dependent upon the men who control, coax, and alone understand, the terribly intricate and absorbingly interesting machinery upon which depends the speed of the ship, her manœuvring powers, the health of the whole of the officers and crew, and even the very fighting capacity of the vessel in action. Almost every weapon of warfare, from the huge turret guns to the deadly torpedo, are in fact to some extent dependent upon the engineer officer.

Of late, a great deal has been written concerning class prejudices between the executive and the engineering branch in the senior service, but that is simply a relic of bygone days. For the last ten years the students who have entered Keyham College have been for the most part public school boys, and have often formed friendships at school with those whom they have afterwards met again as midshipmen or sub-lieutenants in the gunroom of a warship. At the writer's own school, in Hampshire, there were, each year, entered into the Royal Navy about ten cadets to the *Britannia*, and about half a dozen engineer students (now cadets) to the Keyham College, or, as the Admiralty put it, "entered on the books of H.M.S *Vivid*, Devonport."

It may be stated at the outset that the training at Keyham is a strenuous one. That is "the price of Admiralty" that everyone in the senior service has to pay, from Tom Jones, A.B., to the Admiral of the Fleet; but one seldom hears a grumble concerning the strict discipline maintained. The senior students are used to it, and they take good care that the junior men are well broken in on arrival. Entrance is effected by competitive examination (and here it must be understood that the writer is describing throughout the scheme of training which obtains until the new regulations come into force in 1906), and there are usually some two hundred candidates for about forty places. The entrance examination is of a similar standard to the ordinary University Matriculation examination. The successful candidates are required to pass a medical examination to satisfy the Admiralty regulations, which state, among other amusing details, that no candidates will be permitted to enter Keyham who "are mentally deficient"! For this they are medically examined after being successful at the above-mentioned examination!

INCREASED ACCOMMODATION.

For the last fifteen years Keyham College has been the only Admiralty training ground for engineer officers R.N. Previously, H.M.S. *Marlborough*, at Portsmouth, was used for this purpose, but it was deemed advisable to do away with this depôt. Five years ago a new wing was introduced to the College, which greatly conduced to the comfort of the students there by providing reading and billiard rooms, larger lecture rooms and laboratories. There are, at present, about two hundred "engineer cadets" at Keyham. It is not intended to deal with the social life of the cadet, suffice it to say that "my Lords" seem to realise the truth of the maxim that "all work and no play makes Jack a dull boy," for there are provided football and cricket fields, tennis and fives courts, a small flotilla of various rowing and sailing boats, billiard and recreation rooms, while (at least twice a year) dances are held in the large dining hall, to which the cadets invite their friends. Keyham College is especially proud of its Rugby football team, which has on many occasions supplied players for the international contests.

THE UNION OF THEORY AND PRACTICE.

The readers of PAGE'S MAGAZINE, however, will be more interested in the actual daily life of the cadets in workshop, laboratory, and lecture room, than in their exploits in the realm athletic. The course seems to have been devised in order to bring about what Sir Oliver Lodge describes as "the wedding of theory and practice." For the first three years, perhaps, there is more practical experience in the workshop than theoretical instruction in the lecture room, but the balance is made quite even during the last two years, for six months of which the cadet never enters the workshops, but spends his time in the drawing office on design work. For the first year's training, the practical work is done in the cadets' fitting shop in the Keyham Dockyard. The work here is of a very practical nature, and includes the building of such auxiliary machinery as fan engines, circulating pumps, steering engines, and fire and bilge steam pumps. The course is so arranged that a third-year cadet is usually given one of the above pieces of machinery to erect, and has a first-year cadet working under him. In charge of the shop are a certain number of engineer-lieutenants, under whom there are engine-room artificers, each of the latter having about a dozen students under him at a time.

THE SCHOLASTIC STAFF.

The educational course is under the direct supervision of Professor Worthington, F.R.S., C.B., who also gives lectures to the more advanced cadets. It is impossible to adequately express the respect and affection which those who have gone through this somewhat Spartan-like training school have for the Professor and his deputy, John Crocker, Esq., R.N. The engineer officers and the Captain commanding the college are usually only appointed for three years' service, but generation after generation of cadets come in close contact with the scholastic staff, and have ample reason to remember the kind, almost paternal, advice so generously given, as well as the keen interest taken in the individual progress of each and every cadet.

THE COURSE—FIRST YEAR.

During the first year the lectures are in the following subjects: mathematics (algebra, mensuration, and trigonometry), heat, hydrostatics, mechanics, French, and chemistry. Lectures are given for three hours on two mornings of the week, preceded by an hour's

THE BRASS FOUNDRY.

Photo by A. P. Steer, Plymouth.]

THE CAPTAIN OF THE ROYAL NAVAL ENGINEERING COLLEGE AT KEYHAM.

Captain R. S. Lowry, R.N., was born on March 4th, 1854; entered the Navy, December, 1867; became Lieutenant, October, 1875; Commander, December, 1880; and Captain, 1896. While Commander of H.M.S. *Undaunted*, in the Mediterranean, he received the thanks of the French Government, and a pair of Sèvres vases, in recognition of his exertions in helping the French ironclad *Seignelay*, when aground by Jaffa, April, 1891. In 1897 he was appointed Assistant-Director of Naval Intelligence. He is a member of the Council of the Royal United Service Institution, and became Captain of the Royal Naval Engineering College on December 6th, 1902.

THE GYMNASIUM, KEYHAM.

foundry; then two months in the boiler shop, in which place the cadet does tube-rolling, rivetting, hydraulic tests, etc. During the writer's sojourn in this shop there were being built the Belleville boilers for the *Vestal*, Thornycroft, Yarrow, Mumford, and Blechynden boilers, as well as the ordinary cylindrical type. In this, as in all other shops, the foreman is instructed by the Chief Engineer (now Engineer-Captain) of the Dockyard to offer every facility to the cadets and their special instructor to inspect and work on anything which will add to their general knowledge of marine engineering.

The lectures in this fourth year are on the same subjects as those of the third year, but more advanced. Special courses on electrical machinery are also given. It becomes almost compulsory for those cadets who wish to retain premier positions to attend lectures or exercise classes every evening of the week, although the official syllabus only mentions three evenings a week.

FIFTH YEAR.

In the first month of the fifth year's training there is field gunnery training for the cadets, and it is safe to say that, with the majority of them, this is the most popular item of the whole of their training. There are no lectures, no workshops, but the whole of the month of July out in the open air at the Naval Gunnery Grounds overlooking Mount Edgcumbe Park and the Hamoaze. They row across this tidal estuary every morning in the great cutters, or are towed by a Dockyard pinnace, and remain there till 4 p.m., doing squad drill, rifle, Morris tube, or pistol practice, cutlass exercise, or engaging in a single-stick *mêlée*. As a proof of the Spartan-like traditions which they still retain in the senior service, it may be mentioned that in connection with the single-stick practice, each cadet stands alone in an open space armed only with his stick and helmet, while the remaining half squad—*i.e.*, twenty-four cadets—engage in turn in single combat with him! After this month's gunnery training is over, the ordinary routine of the engineering training is resumed, two months being spent in the chief constructor's drawing office to learn something of the construction and under-water fittings of warships; one month in the dynamo repair shop; three months on daily trials of main engines afloat, or taking cruises in the *Sharpshooter* along the Devon and Cornish coasts. These cruises are especially instructive, for, in turn, the cadet does stoking, indicating, log-keeping, works the starting and reversing gear for the whole cruise, bringing the vessel to her moorings at night by keeping one eye on his levers, the other on the engine-room telegraph. On certain days he must turn out very early and go aboard to lay and light fires, getting up steam, and opening and regulating various valves, so that the vessel may be ready for sea at 8 a.m., on the arrival of the other cadets. In order that there shall be no confusion, the steaming classes are small in number, there being usually about ten to a dozen cadets for each party. For the remaining five months the cadet is in the drawing office doing engine design. He must make a complete working drawing of some auxiliary machinery; some will select a dynamo engine, others a fan or circulating pump and engine. Then follows the final examination, lasting more than a fortnight, upon which his commission and subsequent promotion depends. An oral examination by the Chief Inspector of Machinery (now Engineer Rear-Admiral) and two Engineer-Captains is not the least trying of the ordeals of his last year. It is on record, however, that even this awesome tribunal did not prevent one cadet from making an amusing reply. He was asked "what steps would

IN THE PATTERN SHOP.

THE ENGINEER CADETS AT DINNER.

A STEAMING PARTY ON H.M.S. "SHARPSHOOTER."

you take if the main stop-valve of your boiler became disconnected?" His reply was "the stokehold steps, sir!"

THE STATUS OF KEYHAM.

The tremendous complications of a modern man-o'-war are hazily though well realised by those on land, so that any comment by the author is needless. In the words of Engineer-Captain Robert Mayston, R.N., who was for many years Chief Engineer of the Keyham Dockyard, and directly responsible to the Commander-in-Chief at Devonport (at present Admiral Sir Edward Seymour holds this post) for the training of the engineer-cadets, "the facilities afforded at Keyham for the acquirement of a thoroughly practical training, place the Royal Naval Engineering College in the foremost rank as an institution for obtaining a sound knowledge of mechanical engineering. The fact that as soon as possible after entry the student is employed on useful work, the various courses of instruction which are arranged to render the knowledge of marine engineering obtained as complete and as comprehensive as possible, the facilities afforded for acquaintance with running machinery, the constant contact throughout the training with experienced workmen, the frequent opportunities afforded for obtaining information from the officers who have charge of the training, all go to indicate that nothing is spared to make the training of the engineer student complete as possible."

During the last two years the College has been honoured by visits from H.M. the King and T.R.H. the Prince and Princess of Wales, all of whom have carefully inspected the buildings and the cadets, whom they addressed. A pleasing reminder of the visit of the latter are their large autograph photographs to be seen in the cadets' dining hall.

It is impossible to attempt to criticise this admirable training school or the far-sighted policy of the Admiralty advisers. The best proof of its great superiority for training mechanical engineers is that the American universities have had this place as their model for forming their present system. And now the Birmingham University is offering to educate engineers on the American plan!

But there are obvious disadvantages which any university labours under when compared with Keyham. None others than the Admiralty could possibly give the engineer student, *at any fee*, such a training; they could not provide the workshops and the special vessels for steaming practice; perhaps, more than anything, no other training school for engineers could enforce the strict naval discipline so noticeable at Keyham, and which is so greatly responsible for its efficiency.

PHYSICAL TRAINING.

It has been impossible to speak fully of the purely physical side of the training—the compulsory swimming and gymnasium, the athletic sports and the swimming regatta, or of the many trophies won by teams for boating, football, and cricket, etc. But it is hard to resist suggesting that many of our educational experts, who have so assiduously studied the technical training obtainable abroad, might have cast their eyes around in their own country and studied the methods employed by that most efficient branch of the public service—the Admiralty. The greatest proof of this great efficiency is that, in two or three years, the scheme outlined above will have become obsolete, and an eight years' course of training substituted in its stead. But Keyham College (" the R.N.E.C.," as it is called throughout Devonshire and Cornwall, where the cadets are very popular) will still remain the centre of the advanced portion of the engineering education of the naval engineer cadet. The work done there is very real, the scientific instruction sound.

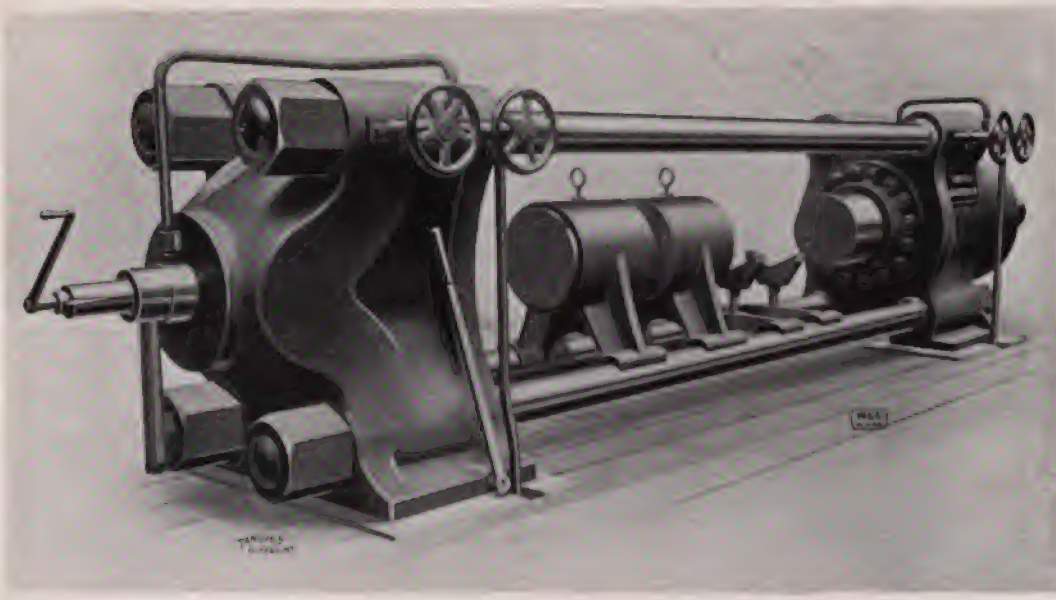


FIG. 8. TUBE-TESTING MACHINE, BY MESSRS. TANGYES, LTD.

TYPICAL ENGLISH TESTING MACHINES.

BY

A. FRANCIS.

Continuing his survey of typical testing machines, commenced in the May number, the author deals successively with machines for the testing of wire, springs, chains, and cement. He discusses the method of obtaining hydraulic power for applying the load, and describes the machines used for testing by impact.—ED.

II.

OWING to cast iron possessing a very dubious elasticity, it is advisable to test this material both transversely and in direct tension, in order to arrive at a correct understanding of the strengths of different meltings and mixtures. The following table, which gives the results of tests of three different mixtures of cast iron, is of interest as showing that a high tensile test is not always to be taken as any guarantee that the transverse test will show correspondingly high results, and *vice versâ* :—

	Tensile.					Transverse.			
Mark	Diameter of Specimen.	Area.	Length between shoulders.	Total load in tons.	Tensile strength per square inch.	Section of test bar.	Distance between supports.	Breaking load in cwts.	Deflection.
A	·74	·43	5 in.	4·88	11·35	2 in. by 1 in.	36 in.	37·5	·44 in.
B	·74	·43	5 in.	7·16	16·65	2 in. by 1 in.	36 in.	34·8	·38 in.
C	·75	·44	5 in.	8·05	18·29	2 in. by 1 in.	36 in.	41·1	·38 in.

NOTE.—The test bars were cast by the West Hydraulic Engineering Company.

It will be seen that the result A shows a much lower tensile and higher transverse strength than B, whilst C is remarkable as being exceedingly strong in tension and well above the average in transverse strength.

Whilst on the subject of cast-iron test bars, it may be as well to remark that the 1 in. square bar machined from a casting gives a more reliable record of the strength of a large casting than the 2 in. by 1 in. bar cast separately; as the former only cools at the same time as the heavy casting, whilst the latter cools very rapidly and consequently possesses a higher transverse strength than would be the case if cooled gradually, giving the carbon time to appear in a graphitic, instead of combined, state.

WIRE TESTERS.

As a contrast to the example shown in fig. 1, page 388, a small wire-testing machine by Messrs, Samuel Denison and Son, of Leeds, is illustrated in fig. 6. As will be seen from the engraving, this

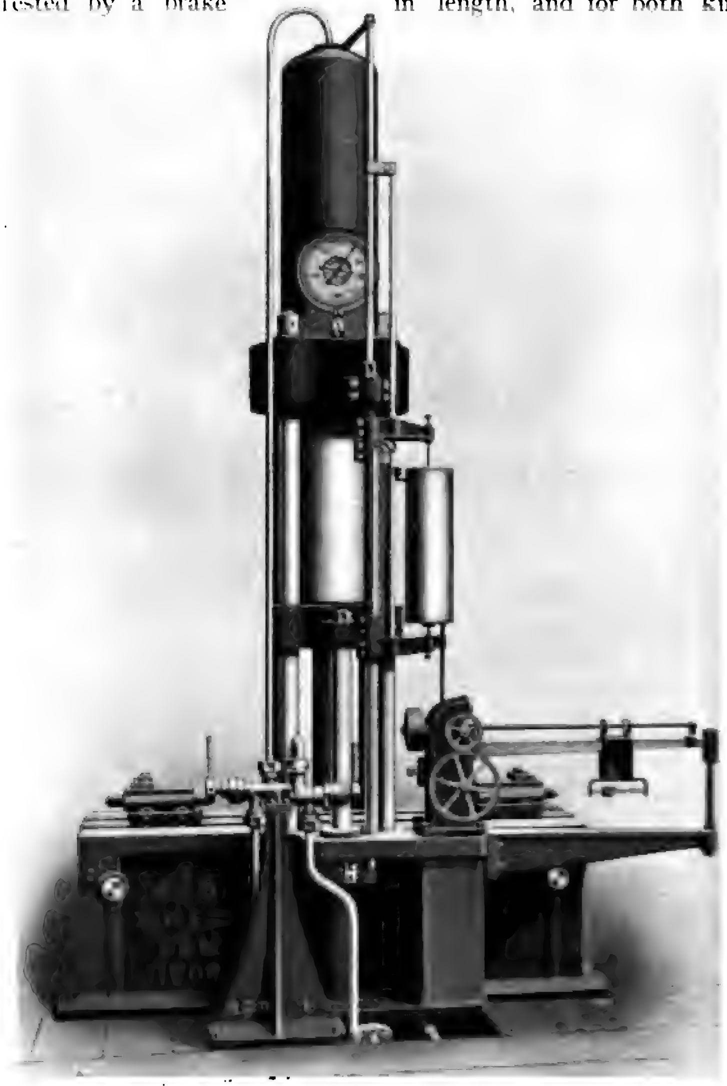
[illegible] which is only of 3,000 lb. capacity, is [illegible] vertical single lever variety, with screw-propelled poise. The straining mechanism takes [illegible] an eccentric actuated through worm [illegible] gearing, and the clips for holding the [illegible] have their jaws geared together. The [illegible] wheels for applying the load and moving [illegible] are conveniently placed together in [illegible] position that the observer can manipulate [illegible] and keep his eye on the swing of [illegible] position of the poise.

[illegible] some of this firm's wire testers, the movement of the poise is effected by the action of a [illegible] weight, which is arrested by a brake [illegible] when the lever [illegible] and the operator [illegible] devote his attention to taking up the stretch of the specimen.

SPRING TESTING MACHINES.

Judging from the appearance of the numerous types of spring testing machines made in this country, very little attention seems to have been lavished upon their design, and, if possible, less care devoted to their construction. From this criticism must be excepted the machine shown in the accompanying illustration. This machine was recently supplied to Woolwich Arsenal by the West Hydraulic Engineering Company, of 23, College Hill, E.C. In general design it is similar to the one noticed in this magazine (February, 1904), but several refinements of detail have been added. In this machine the poise weight for indicating the load is propelled by a screw and gearing, whilst supplementary poises are used for counterbalancing the weight of any carriages used for supporting the spring, and also for taring the spring itself, so that the steelyard reading is that of the *net* load on the spring. The steelyard is engraved to represent tons and ·1 tons, and a micrometer disc at the neutral end indicates increments of ·01 and ·001 tons.

It will be noticed from the engraving that the autographic recorder is of unusual length, in order to give a full-size diagram of the deflection up to 21 in. The machine itself is also of considerable height, being capable of taking in either spiral or laminated springs up to 50 in. in length, and for both kinds of



THE "WEST HYDRAULIC" SPRING-TESTING MACHINE.

springs anti-friction carriages are provided; for spiral springs there is a ball-bearing plate which allows the spring to rotate under compression. A novel type of carriage for the ends of laminated springs has been designed to reduce friction as far as possible; this has been effected by making the carriages with loose tops, which rest on frames carrying loosely held rollers, so that the only loss is that due to static friction. The power of the machine is 25 tons, and existing pressure mains of 750 lb. per square inch were utilised for supplying the main and side rams.

The West Hydraulic Engineering Company are at present engaged on new designs of tensile and fatigue testing machines, but, on account of matters connected with the patents, the author is not in a position to do more than intimate that the fatigue machine is hydraulically operated, but without any valves being employed.

Mention should be made of an ingenious fatigue testing machine recently patented and designed by Professor Fidler, of Dundee University. In this machine, the specimen to be tested is connected at one end to an annular hydraulic chamber or "sack" of sufficient elasticity to distend when pressure water or oil is admitted into it, and thus exert a stress on the specimen; the other end of the test piece is held by a grip so arranged that any deformation of the piece can be taken up by a screw and nut. Prof. Fidler, in his patent, claims a special arrangement of valves which are actuated by a pulley driven from a rotating shaft; at every revolution of the pulley the pressure is first admitted to and then released from the hydraulic sack; or, if it is desired to test a specimen between maximum and minimum loads, the valve is modified to admit alternatively high and low pressures from separate mains.

FIG. 6. WIRE-TESTING MACHINE, BY MESSRS. SAMUEL DENISON AND SON. Capacity 3,000 lb.

CHAIN TESTING MACHINES.

Machines for testing and proving chains are made by nearly all the firms mentioned in this article, and also by the majority of weighing machine

manufacturers. As might be expected, those firms who make horizontal tensile testing machines use the same patterns for the load indicating ends of chain testing machines, and place the hydraulic straining ram at the other end of the cast iron girders, which form the sides of the chain pit. In the "Buckton" chain testing machines the load measuring apparatus and the straining cylinder are at the same end of the machine ; this is a very convenient arrangement, if somewhat more costly than the other. A cheaper class of machine is that consisting of a long cast-iron bed at one end of which is fitted an hydraulic cylinder and ram, and the load on the chain is computed, approximately, from the pressure in the cylinder. In ordinary machines of this class, the accuracy is seldom within 5 per cent., and is, unfortunately, inconstant, varying within somewhat wide limits from day to day, and consequently the results are not very reliable for testing, but are, perhaps, sufficiently close for private proofs.

To prevent accidents to the operator or machine, due to flying links or chain ends, it is a good plan to follow the American custom of placing the weighing portion of the machine in a small room at the end of the chain pit shed. from which it is divided by a stout wall of brick or concrete.

THE TESTING OF PIPES AND TUBES.

Pipes and tubes are tested and proved by internal hydraulic pressure, and fig. 8, page 503, can be taken as representative of the best type of machine used for this class of test. This machine was made by Messrs. Tangyes, Ltd., of Birmingham, for the Spanish Government, and specially designed for testing gun tubes. There will be no need to give any description of the mode of working, as this will be made quite clear from an inspection of the engraving. Mention should, however, be made that by a special arrangement of valves, the air in the tube can be replaced by the low pressure water before the final high pressure supply is turned on. This is a very necessary precaution, as, apart from the danger of a tube or pipe bursting when it contains such an elastic fluid as air, there is also the possibility of the upper portion of the tube being unsound without being detected if the tube is not completely filled with water.

CEMENT TESTING.

For ascertaining the tensile strength of cement, small briquettes, usually 1 in. by 1 in. section at the waist, are broken in small specially constructed machines of about 1,000 lb. capacity. Such a machine is illustrated herewith. This is one of the numerous types of cement testers made by Messrs. W. H. Bailey and Co., Ltd., of Salford, whose name has been associated with the manufacture of testing apparatus for a very extended period. In the machine in fig. 9, the load is applied to the cement by the action of water trickling into the suspended can at the end of the lever, a small screw is used to keep the lever floating in a horizontal position. As soon as fracture takes place, the consequent dip of the lever cuts off the water supply, and the breaking load is read off a suitably calibrated gauge glass on the side of the canister. In some Bailey machines sand or fine shot is employed in lieu of water. In other forms of small testing machines, this firm adopt the Thomasset and Mailliard principle, in which the load is indicated through the instrumentality of a mercury column and reducing diaphragm.

HYDRAULIC POWER FOR APPLYING THE LOAD.

With English testing machines of large or medium capacity it is necessary to have hydraulic power for applying the load, and to those about to instal machines there is a wide field of choice in the manner of generating the required hydraulic power. The following are the arrangements most usually adopted : If existing hydraulic mains are available the testing machines can be ordered with straining cylinders of suitable area for the water pressure,

FIG. 9. CEMENT TESTER, BY MESSRS. W. H. BAILEY AND CO.

or the latter can be raised by means of an intensifier to suit makers' standard pattern machines. In many works, pumps are directly connected to the cylinders and such are sometimes hand or belt-driven, and occasionally duplex steam pumps. In the case of belt-driven pumps it is advisable to have the plungers operated through link motion, designed to vary the throw between zero and the maximum. It is almost superfluous to remark that in this case only three plunger pumps should be employed.

SCREW COMPRESSORS.

A third source of supply is the screw compressor, to which some makers prefer to give its French title, "Compresseur sterhydraulique," and others again split the difference by describing the apparatus partly in English and partly in French. One of these screw compressors is illustrated in fig. 10, and has been selected as the best designed English machine of this type. A glance at the engraving will be sufficient to prove that the makers—Messrs. Greenwood and Batley—have spared no pains in the design, and the neat arrangement of friction clutches and automatic trip at the limits of stroke is far superior to the fast and loose pulleys employed by other firms.

FIG. 10. SCREW COMPRESSOR, BY MESSRS. GREENWOOD AND BATLEY.

The most convenient power plant for a testing laboratory is that introduced by Prof. Kennedy, of having it entirely self-contained with its own pumps and "variable load" accumulator. The accumulator should be of sufficient capacity to allow of the machine making a complete test with the pumps at rest to avoid any shocks or vibration caused by "water hammer."

THE KIRKALDY MACHINE.

The first satisfactory English testing machine with any claim to convenience in manipulation was that designed by the late Mr. David Kirkaldy in 1863, and constructed by Messrs. Greenwood and Batley. Mr. Kirkaldy was not lacking in confidence regarding his own ability as a designer, for the first machine he had constructed was one of 450 tons power, destined to form the nucleus of the Southwark Testing Works, which have since attained such a world-wide reputation.

The Kirkaldy machine was not by any means the first testing machine made in this country, as Barlow had used a simple machine loaded with cannon balls as early as 1826, and in 1837 he had a Bramah machine built with hydraulic straining ram and a bent weighing lever, for testing chain cables at Woolwich Dockyard.

TESTING BY IMPACT.

Of recent years the resistance of materials to impact has received some attention, and it is probable that this property will be very carefully considered in the near future in connection with the heat treatment of steel. It is possible to get two specimens of steel having the same ultimate tensile and elastic strengths with the same percentage of elongation on similar lengths, yet varying very widely as regards their brittleness.

The machines used for testing by impact are of two varieties: (1) Those in which the impact is due to a weight falling in vertical guides; and (2) those in which the weight is arranged as a pendulum. In the former machines, a weight is either caused to fall from increasing distances until fracture takes place or the height of drop is the same and the number of blows required to break the specimen is recorded. In the second class, the pendulous weight is generally made to fracture the specimen at the first blow, and the power absorbed in so doing is computed from the height the pendulum swings to, after breaking the specimen.

In conclusion, the author wishes to express his thanks to those firms who have been kind enough to provide the photographs from which the blocks have been made to illustrate this article, and also for permission to reproduce them.

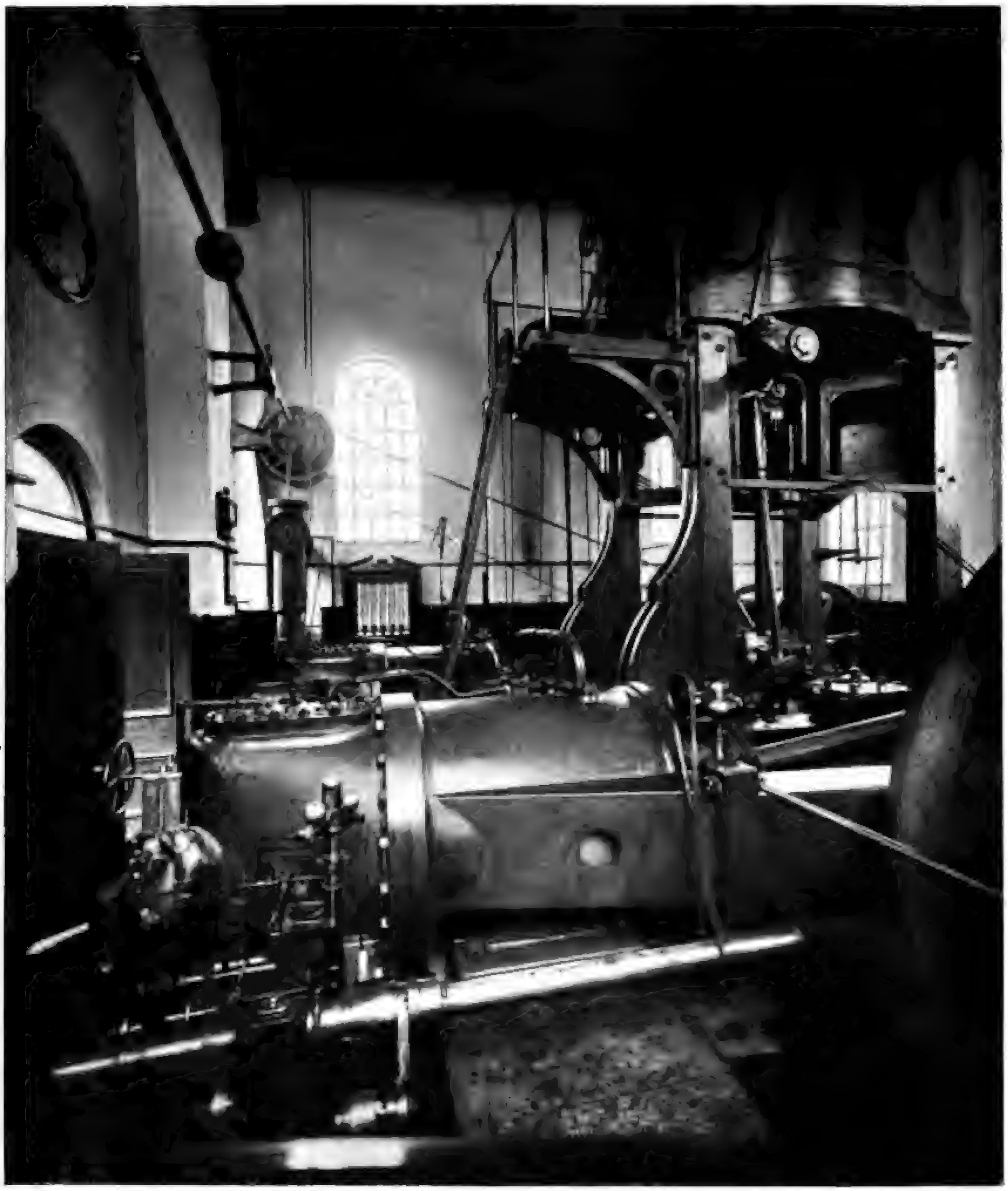


FIG. 2. DUPLEX CYLINDER SINGLE-ACTING 400 B.H.P. THWAITE GAS BLOWING ENGINE.
For the Clay-Cross Iron Works, Chesterfield.

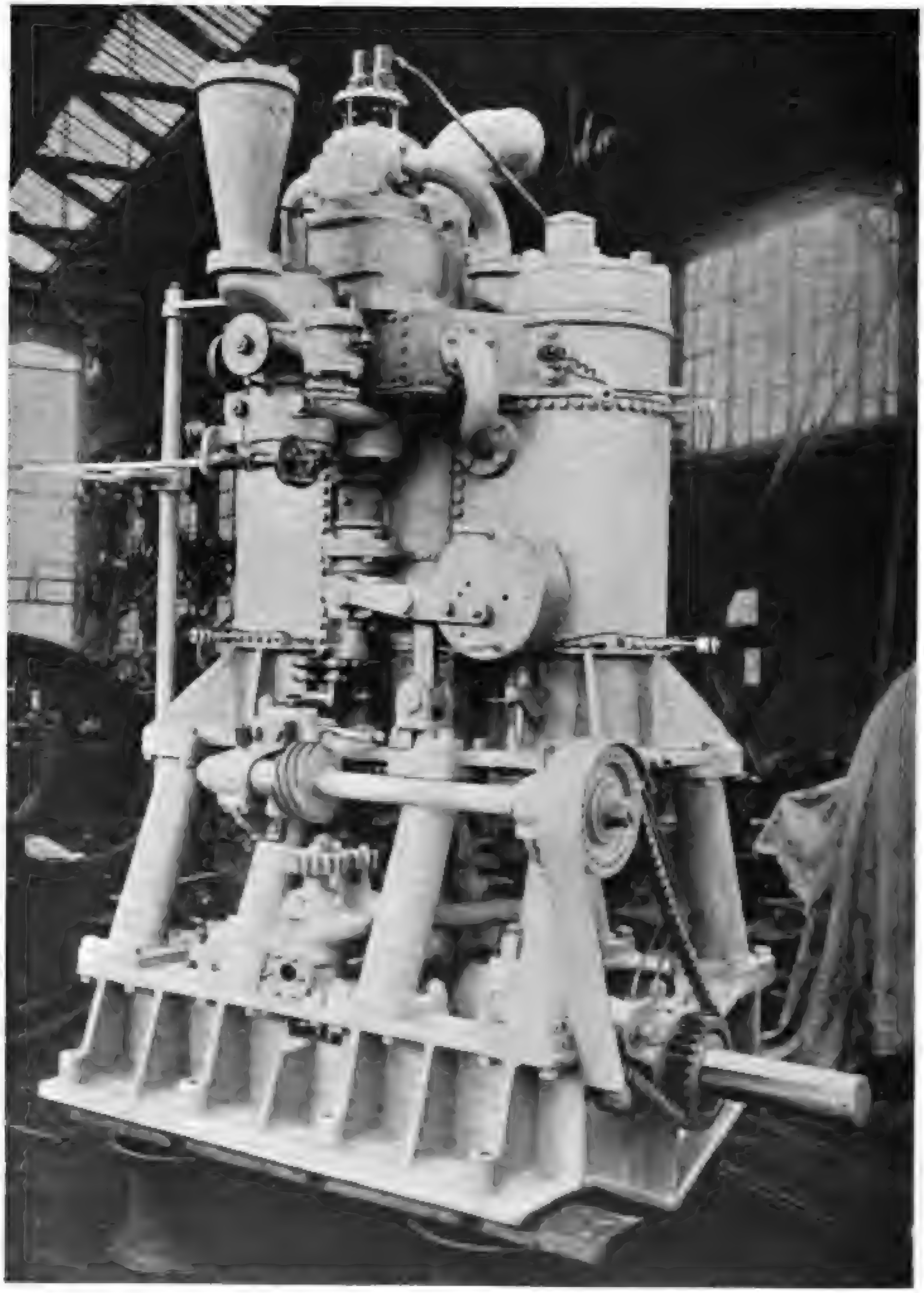


FIG. 3. THREE-CYLINDER COMPOUND BUTLER GAS ENGINE.
For the Victoria Works, Gateshead.

the cylinder liner being cast separately, and securely contracted into position by a special process used by the Nuernberg Engine Company in the manufacture of large steam engines.

In engines of the two-cycle type, such as the Koerting and Oechelhauser, there is less accumulation of dust deposit in the explosion chambers, owing to the scouring action of the blown-in charge of gas and air at each stroke. A very widely different type of engine i the Voght, which it is claimed is entirely immune from dust troubles. This engine is arranged with an hydraulic cushion at each side of the piston, so that the cylinder and explosion chamber walls are actually washed by contact with water; this engine also works on the two-cycle system.

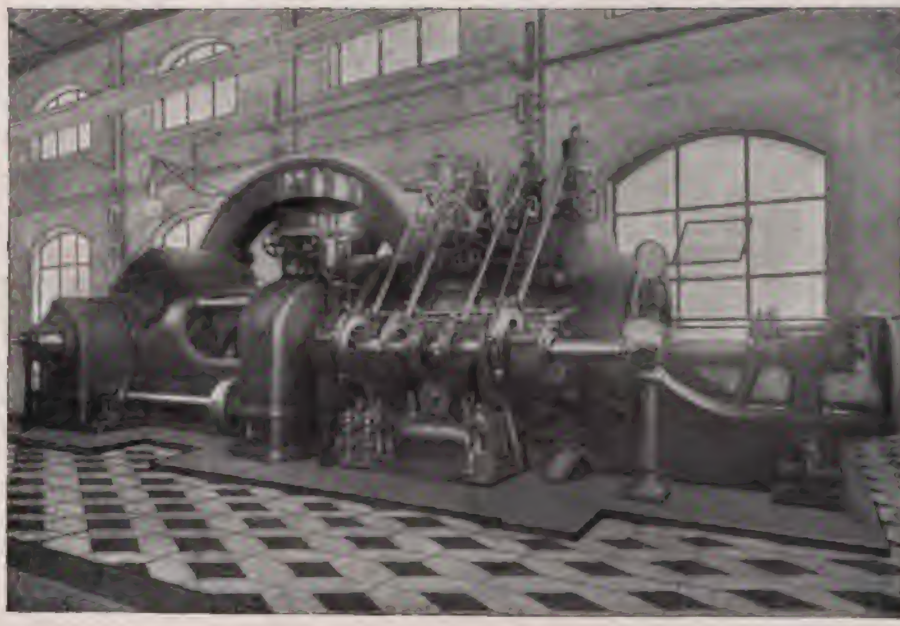


FIG. 4. MONO-CYLINDER DOUBLE ACTING 350 B.H.P. NUERNBERG GAS ENGINE. For the Town Council Electric Station, Pisa.

Like the Cockeril and Westinghouse engines, this type is built both single and double-acting, and arranged either as mono-cylinder single, or double acting engines, or duplex with tandem cylinders. In the illustration (fig. 1), a coupled twin engine is shown, with duplex single-acting cylinders; the four cylinders are collectively capable of developing 1,200 b.h.p. on furnace gas, and are arranged in separate pairs at each side of an alternator and fly-wheel. Another engine of this make, but of a more modern type, is shown by fig. 4; this is a mono-cylinder double-acting engine of 350 b.h.p.

A strong point in engines of this make is the method of ensuring that all the weight of the piston and rod is carried by the guide slippers; in obtaining this result, the rod is given a slight permanent deflection upwards. The rod, piston, and exhaust valves are thoroughly water cooled, as in the Cockeril, Westinghouse, and other engines of large size.

In the Nuernberg engine, a very efficient design of packing gland box is used to prevent escape of gas past the piston rod. In addition to the series of segmental metallic rings, arranged in wedge formation, so as to press alternately inwards and outwards, a second series of inwardly sprung rings is also used. Both series are thoroughly lubricated by separate oil force pumps, and efficiently water-cooled. The Nuernberg engines are built in duplex double-acting form up to 2,000 b.h.p., and as double-coupled engines up to twice this power.

Another type is the Thwaite gas blowing engine, which consists of two single-acting explosion cylinders, coupled to an inverted vertical blowing cylinder, illustrated by fig. 2. This engine of 400 b.h.p. is provided with special scavenging valves, which feed a flushing charge of air to the explosion chambers after each working stroke; the air being drawn from the blowing cylinder. In the duplex dos-à-dos single-acting engine, of this make, special regard is paid to clearing out dust accumulation by arranging both pistons so as to be easily dismantled. These engines are built with an unusually long stroke, advantage being taken to cut off the explosive mixture supply at about five-eighths the stroke, and so reduce the terminal pressure and economise power.

Another design of engine built to economise the power usually allowed to go to waste is illustrated by fig. 3. This is a three-cylinder inverted single-acting compound engine, with scavenging action; this engine was designed by the writer for use with furnace and producer gas, and has given some very good results. In order to eliminate any trouble from dust deposit on the valves and seats, a rotary form of distributing valve is used, which is entirely balanced and held automatically up to its seat. The revolving action effectually maintains a clear and bright surface to both valve and seat.

In reviewing the several different types of two and four-cycle engines described in this article, it may be, in conclusion, interesting to note the advantage of having at least one working stroke per half revolution of the crank shaft, as compared with engines in which only one thrust is obtained for alternate revolutions, as in the case of the mono single-acting cylinder engine used for small powers.

The tendency to angular deviation of velocity in the various types may be expressed in values as follows:—For a mono single-acting cylinder four-cycle engine a cyclic deviation of 18; for a vis-à-vis four-cycle engine (with one crank), a cyclic deviation of 12; for duplex cylinder single-acting four-cycle engines and for single-cylinder two-cycle engines a cyclic deviation of 4 may be expressed. While for the compound engine (shown by fig. 1), the value is 3, and for the same made double-acting, the deviation would be $\frac{3}{4}$ only.

The Official Trials of the Lake Submarine.

THE submarine boat *Protector*, designed by Mr. Simon Lake, and described in detail in PAGE'S MAGAZINE last year, has so successfully undergone the trials of the United States Naval Board, that it has been decided to purchase five submarines of this type — one for the School of Submarine Defence (for experimental work), one for the eastern entrance of Long Island Sound, one for the entrance to Chesapeake Bay, one for San Francisco Harbour, and one for Puget Sound.

FUNCTIONS OF THE LAKE SUBMARINE IN NAVAL WARFARE.

The functions of the Lake boat in Naval warfare are stated by the Board as follows:

For defence — (1) To take the place of fixed mines, by lying adjacent to the forts and attacking vessels attempting to reduce the works or to run past, particularly in important channels where it is impracticable to plant mines, owing to deep and rough water, extreme width, or the swiftness of currents.

(2) To supplement fixed mines by attacking vessels approaching the mine fields or those which have crossed them.

(3) To lie outside mine fields for scouting or picket duty, keeping in telephonic communication as hereafter described.

(4) To pick up and to repair defective cable joints [illegible] boxes, etc.

For attack — [illegible] run past the forts and to [illegible] vessels within the harbour.

[illegible]

THE DIVING COMPARTMENT.

[illegible]

to the low-pressure air system, and provided with a telephone communication with the living space, and a hydro-pneumatic gauge with two hands, one of which registers the pressure of the water outside—due to depth—and the other the air pressure in the compartment. At the bottom of the compartment is an iron door, which can be opened outward. To open the door, the air-lock doors are first closed, and compressed air is admitted into the compartment until the gauge hands indicate unity of air and water pressures. The door is then unfastened and allowed to swing open, thus giving, in clear water with the boat on the bottom, a good view of the sea bed.

This compartment provides for:

1. Mine cable cutting; or else repair of, or the burying of, mine cables and junction-boxes.
2. A channel for telephonic communication with the shore when the boat is on picket duty.
3. A way of escape for the crew, in case of the total disablement of the boat.

THE OFFICIAL TESTS.

On the occasion of the tests, the Board was on board from 10.15 a.m. to 4 p.m. From about 12 noon to 3 p.m. the boat was submerged, and from 12.40 to 2 p.m. the Board was in the diving compartment, observing its operation and that of grappling for a cable. No discomfort was experienced under the air pressure in the diving chamber, and the remaining part of the interior was quite as comfortable as any surface boat of its size would have been. Lunch was cooked and served while submerged.

The following was the day's programme:

(1) Proceeded from Fort Adams (Newport, R.I.) some three miles up Narragansett Bay in cruising condition, using engines.

(2) Passed from cruising to awash condition, housing all external fittings except a wooden mast installed for the naval test.

(3) Continued surface run in awash condition.

(4) Passed to submerged condition by filling ballast tanks.

(5) Manœuvred on the bottom of the bay, by using [illegible] and motors to propel the boat.

[illegible] chamber with compressed air [illegible] and, with a grapnel, picked

up a telephone cable by moving slowly over its approximate position.

(7) Passed from submerged to awash, and thence to cruising condition, and returned to Fort Adams by a surface run, using storage batteries and motors.

It was found that in passing from the submerged to the awash condition an ice floe had drifted over the boat, which, on rising, broke through the floe and emerged with its deck completely covered with some eight inches or more of ice, which remained on deck while passing to the cruising condition. It was also found that the wooden mast above-mentioned had been broken by the ice while the boat was manœuvring under it. The weather was very cold (zero), the bay full of ice, and it would have been difficult to have chosen more adverse conditions for the test.

THE BOARD'S CONCLUSIONS.

The Board states its belief that this type of submarine boat is a most valuable auxiliary to the fixed mine defence, and, in cases where channels cannot be mined owing to depth, rough water, swift tides, or width of channel, it will give the nearest approach to absolute protection at present known. The boat can lie for an indefinite time adjacent to the point to be defended, in either cruising, awash, or submerged condition, by its anchors being upon the bottom. It is thus ready for instant use, practically independent of the state of the water, and in telephonic connection with the shore. It can also patrol a mined or unmined channel, invisible to the enemy, and able to discharge its torpedoes at all times. It possesses the power of utilising its engines in every condition except the totally submerged, and can always charge its storage batteries while so doing, necessitating its return to shore only when gasoline must be replenished. In narrow channels the boat or boats would have a fixed position, with a telephone cable buoyed or anchored at the bottom. In wide channels they would patrol or lie in mid-channel, or where they could readily meet approaching vessels.

As a picket or scout boat, outside the mine field or even at extreme range of gun fire, telephone communication can be sustained, and information received and instructions sent for attacking approaching vessels.

The test served to demonstrate the ease with which the boat can locate and pick up cables and, with minor alterations in the present model, junction-boxes, etc., can be taken into the diving compartment and repaired at leisure while absolutely protected from hostile interference. The faculty possessed by the boat of manœuvring on the bottom and sending out divers, leaves little or nothing to be desired in its facilities for doing this work.

FOR ATTACK.

The boat shows great superiority over any existing means of attacking mine fields known to the Board.

It can run by any mine field, as at present installed, with but little or no danger from the explosion of any particular mine or from gun-fire, during the few seconds it exposes the sighting-hood for observation, and can attack at its pleasure vessels in the harbour.

The Board personally witnessed the ease with which cables can be grappled, raised and cut, while the boat is manœuvring on the bottom. Mine cables can be swept for, found and cut, or a diver can be sent out for that purpose.

With one exception, no seamen are needed aboard, this exception being the man who steers and handles the boat.

The crew is as follows: One navigator, who is also the diver; one chief engineer, one assistant engineer, one electrician, one machinist, one deck hand, one cook.

The question of the use of the Whitehead torpedo as part of the fixed mine defence, fired from tubes on shore, is now receiving consideration. Where channels are wide and waters swift, this use of the Whitehead will be very limited. With boats of this type the Whitehead can, it is believed, be carried within certain effective range in all ordinary channels.

THE "PROTECTOR" RUNNING AT FULL SPEED.

THE IRON AND STEEL INSTITUTE.

ANNUAL MEETING AT WESTMINSTER.

MR. ANDREW CARNEGIE (President), taking the chair at the thirty-fifth annual meeting of the Iron and Steel Institute, held at the Institution of Civil Engineers, congratulated the large attendance upon the prevailing sunshine, and expressed the hope that similarly there might be no clouds upon the proceedings. It may be said at once that the hope was entirely justified.

The annual report read by Mr. Bennett Brough (secretary) presented an excellent summary of the year's work as chronicled from time to time in our columns. The membership roll on December 31st last was 1,781, as compared with 1,443 in 1893, 1,132 in 1883, and 631 in 1873.

Several members were congratulated upon high distinctions which had been conferred upon them, including the following, among others :—

Sir W. T. Lewis, Bart., vice-president, appointed a member of the Royal Commission on Trade Disputes and Trade Combinations ; Mr. Victor Cavendish, M.P., member of Council, appointed Financial Secretary to the Treasury ; Sir Alfred Hickman, M.P., created a baronet ; Mr. Stead, member of Council, elected a Fellow of the Royal Society, and appointed the representative of Great Britain on the Council of the International Testing Association ; Sir John Aird, recipient of the Grand Cordon of the Imperial Ottoman Order of the Medjidieh ; Mr. W. F. Beardshaw, re-elected President of the Sheffield Chamber of Commerce ; Professor J. A. Ewing, elected an honorary fellow of King's College, Cambridge, and appointed a member of the Explosives Committee in succession to the late Sir W. Roberts-Austen ; Sir James Steel (Edinburgh), created a baronet ; and Mr. J. H. Wicksteed, elected President of the Institution of Mechanical Engineers.

It was shown that the Institute had been more than usually prolific in regard to the number of papers (twenty-eight) contributed during the year, and the Council were able to record that during the year the Institute had made very satisfactory progress.

As the honorary treasurer had been unable to get nearer the meeting than Gibraltar, his interesting report was read by the secretary. It was shown that the past year's income was the highest recorded in the history of the Institute, while the expenditure was also the largest which had ever occurred. The honorary treasurer recorded, with satisfaction, a credit balance of £219 2s. 10d., which more than wiped out the last year's deficit of £116 14s. 5d. The expenditure of 1903 amounted to £5,205, while the receipts from all sources were £5,424.

The extraordinary expenditure comprised subventions of £200 to the National Physical Laboratory, £100 to the Engineering Standards Committee, and £5 to the International Testing Association.

With regard to the Carnegie Scholarships Fund, the position was thoroughly satisfactory. The income for the past year was £624 11s. 5d., and the expenditure £551 15s. 11d., leaving a small balance to bring forward.

The report and accounts having been adopted on the motion of the president, Professor Bauerman moved a vote of thanks to that gentleman and the Council for their services during the past year. This was seconded by Mr. A. Lamberton (president of the West of Scotland Iron and Steel Institute), and was also carried unanimously.

MR. CARNEGIE PRESENTS MEDALS.

Mr. Carnegie now entered upon the performance of a series of duties which he seemed thoroughly to enjoy, viz., the presentation of medals, and more particularly the Bessemer Gold Medal, awarded to Mr. R. A. Hadfield for his researches in metallurgy.

This, of course, was the occasion for a characteristic speech, which the president commenced with calm and deliberate utterance—medal in one hand, the other hand in trousers pocket. Mr. Hadfield also seemed inclined to regard the occasion as one of some solemnity, until Mr. Carnegie, warming to his work, introduced several happy touches in lighter vein, and finally the two distinguished men faced one another smiling and shaking hands most heartily.

The test of success, remarked Mr. Carnegie, was the man's position in the line which he chose to attack and conquer, and Mr. Hadfield had achieved the rare distinction of being foremost in the line which he had chosen and mastered. His position was not equalled, as far as he knew, in the world in the special line that he had chosen ; and, therefore, they hailed before him as a master among men. He took unusual pleasure in the fact that the Institute, having gone so far as to venture upon an Anglo-American president, bestowed the Bessemer medal upon one whose better-half he should claim as an American. He took it that Mr. Hadfield, himself, and others, having interests and affections and love for both branches of the race, might stand before the world as typical ties, binding the two branches together in a friendship and in a relationship which would never be marred by the slightest friction ; that as the two branches of the race went forward in the world to the great work before them they would go hand in hand. "So, sir," he

concluded, "say to your wife, when you take home this medal, that it is not British but it is British-American—a joint possession to be treasured as one of the heirlooms of your family."

In the course of his reply Mr. Hadfield said he regarded this great honour not merely as a personal one, but as also given to him as a representative of that great city from which he had sprung—Sheffield—where, more than 140 years ago, Huntsman first made steel, and which was still the leading centre in the world for the highest quality of material and wide range of special products. He knew of only one objection to the Bessemer Medal, and that was, it should have been made of Bessemer's steel rather than of gold. If it were only possible to obtain some of Bessemer's original or first product from which to make the medals presented each year, how much more precious than gold would have been such a memento of a name and a material which had helped to revolutionise the world. This honour, so much prized, carried with it responsibility of no mean order. It was specially gratifying to receive the medal at the hands of Mr. Carnegie, coming as he did from the great Republic over the sea, whose aspirations and aims were very similar to their own. He had on so many occasions received there such kindly encouragement and assistance, that it was indeed most pleasing that Mr. Carnegie had placed in his hands the distinction admitted by all to be the "blue ribbon" of the metallurgical world. As to any merit in his work that the Institute had seen fit to recognise, he could only say that, if merit there were, it had been entirely due to persistent hard work.

As regards his work on alloys of iron and steel, at the time he presented his first alloy research—that on the discovery of manganese steel—the systematic study of alloys of iron with other elements was practically virgin ground. He freely acknowledged the great assistance and co-operation he had had from time to time from a host of friends, from the most eminent physicists, chemists, and brother metallurgists. To mention only a few, he expressed special indebtedness to M. Osmond, Professor Barrett, Dr. Sorby, Dr. Fleming, Professor Kennedy, Professor Arnold, Mr. Stead, the late Mr. J. F. Barnaby, Professor Ledebur, and Professor H. M. Howe. To members of his own staff also, he had been most greatly indebted. As of historic interest he had placed on the table specimens of the first manganese-iron alloy he made twenty-two years ago. These he would now be very pleased to present to the Institute. (Applause.)

Next came the presentation of the Andrew Carnegie gold medal to Mons. P. Breuil, of Paris. This gentleman had written a letter of thanks, which the president read to the meeting. In it Mons. Breuil said that what gave him the greatest pleasure of all was the thought of the profound joy which would be experienced by his parents, two good French peasants, now advanced in years, poor and infirm, and living in a remote country village, on learning that their son had achieved so high a mark of distinction. "Gentlemen, if I had written volumes upon his character, I could not have revealed the man more to you than in those few words"—was the comment of Mr. Carnegie. The president also addressed to Mons. Breuil a few kindly and appreciative remarks expressing the hope that he would be one of that noble band—Pasteur, Berthelot, and Curie.

Mons. Breuil was evidently thinking more about his parents and about Mr. Carnegie than of the medal, for he left the platform without it, but this omission was quickly repaired, and the Frenchman retired to his seat looking supremely happy.

Mr. Percy Longmuir then came to the platform to receive the special silver medal. The president remarked that the recipient was one of those engaged in discovering the mysteries of steel (he believed that was what Mr. Stead called it), and he had made some rare discoveries. The Institute thought so highly of them that they have thought fit to present a special medal, and he had been considered by the unanimous vote of the Council worthy of it. They gave it to him predicting for him a great career in the future. He had begun well, and a good beginning was half the battle.

RESEARCH SCHOLARSHIPS.

The Secretary presented details of the Andrew Carnegie Research Scholarships for 1904. The names of the recipients are appended, with a few personal details:—

John Dixon Brunton, studied for four years in the Metallurgical Department of University College, Sheffield, and is now manager of W. N. Brunton and Sons' Wire Mills, Musselburgh.

Henry Cort Harold Carpenter, studied at Oxford for three years, at Leipsic for two years, and at Manchester for one year. For the past two years he has been assistant in the Metallurgical Department of the National Physical Laboratory.

Edwin Gilbert Llewellyn Roberts, studied at the City and Guilds of London Institute at Finsbury, and at the Royal School of Mines. He is now Demonstrator in Metallurgy at the latter institution.

Ernest Alfred Wraight, studied at the Royal School of Mines, where he is now Demonstrator in Metallurgy.

Frank Rogers, B.Sc., studied at University College, Liverpool, and obtained an 1851 Exhibition Scholarship, which he is holding at Cambridge.

Walter Rosenhain, studied at the University of Melbourne, and has carried out some important researches with Professor Ewing at Cambridge. He is now scientific adviser to Messrs. Chance Bros. and Co., Ltd., Birmingham.

Octave Boudouard is Demonstrator of Chemistry at the College of France. He has received the medals of the Société d'Encouragement, and of the Chemical Society for research, and received a special Carnegie medal from the Iron and Steel Institute in 1903.

Pierre Breuil, who receives the Andrew Carnegie Gold Medal, was for five years in charge of the laboratory for the mechanical testing of metals for the Paris, Lyons and Mediterranean Railway. He is now Director of the Testing Laboratory of the Conservatoire des Arts et Metiers.

Percy Longmuir, studied at University College, Sheffield, and has had a practical training in foundry work. He received a Carnegie Research Scholarship in 1902, which was renewed in 1903. He is now assistant at the National Physical Laboratory.

THE PAPERS.

Some thirteen papers, covering a wide range of subjects, were presented. On the morning of the opening day, it was found possible to include three of these.

EXPLOSIONS FROM FERRO-SILICON.

Mr. A. Dupré, Chemical Adviser to the Explosives Department at the Home Office,

and Capt. M. B. Lloyd, Inspector of Explosives, lead off with a paper on "Explosions Produced by Ferro-silicon." This placed the Institution in possession of the facts which had been obtained as the result of their inquiries into several explosions which occurred in connection with a consignment of this material at the Alexandra Dock, Liverpool.

It was shown that these explosions are probably due, not to the ferro-silicon itself, but to the presence of impurities, and more particularly to the phosphorus compounds contained in it. The best method of avoiding such risks in future would be to use such materials only as are free from phosphorus, or if this be found impossible, to fill up the drums with paraffin oil of high flashing-point; or, lastly, by submerging the finely divided material in water until all action has ceased, and drying the material before packing, as it is improbable that on a large scale every particle of phosphide of calcium or other gas-generating substance would be removed by this latter treatment. The drums used should, as an additional precaution, be perfectly watertight, and of such strength and construction as not to be liable to become insecure under the ordinary conditions of transport.

The paper was followed by a discussion, to which contributions were made by Mr. Watson Gray, Mr. J. E. Stead, Prof. Harbord, and Prof. Le Chatelier.

PIG-IRON FROM BRIQUETTES AT HERRÄNG.

With the aid of a great number of diagrams, Professor Henry Louis, of Newcastle-on-Tyne, described the scheme of operations which have been commenced on the Herräng mining property, sixty miles north of Stockholm. These have been rendered possible by the ingenious inventions of Mr. Gustaf Gröndal, who has superintended the erection of the works.

The ore as mined is conveyed from the various mines by aerial wire ropeways to the crushing works, where it is broken and crushed wet; the pulp thus produced runs to the magnetic concentrators, which take out the magnetite; the latter is conveyed by a small aerial ropeway to the briquetting-house, where it is stamped into briquettes, which pass next through the briquetting-furnace in which they are burnt; they are then hoisted up to the top of a pair of charcoal-furnaces, where they are smelted for high-class pig iron; the waste gases from the blast-furnace fire the briquetting-furnaces, and supply gas engines which furnish the blast and also drive the dynamos of a central electrical station, from which power is conveyed to the concentrating works, as well as to the various mines for hoisting, pumping, etc.

The paper explained the details of the plant at some length, the author mentioning that the works had already fully borne out his anticipations with regard to economic working. It was discussed by Mr. A. P. Head, Dr. Weiskopf, and Prof. Bauerman.

The Production and Thermal Treatment of Steel in Large Masses.

THE paper read by Mr. Cosmo Johns emphasised the difference in the conditions obtaining in large works and those governing laboratory experiments. In the thermal treatment of steel in large works "mass" and "time" were important considerations. A brief but interesting description was given of the practice at the River Don Works of Messrs. Vickers, Sons and Maxim, Ltd., at Sheffield.

MELTING.

All the steel produced at the River Don Works, with the exception of a relatively small portion made by the crucible process, is made in acid-lined open-hearth furnaces. It has been found that high-class steels, such as those referred to in this paper, used for the manufacture of guns, heavy shaftings, tires, axles, etc., can only be produced satisfactorily by the acid open-hearth process. The chemical purity, by which the author means a low percentage of phosphorus and sulphur, is secured by the careful selection of the materials used. No difficulty is found in obtaining a product under 0·035 phosphorus and sulphur. The object aimed at is to reproduce in the bath as nearly as possible the condition found in "well killed" crucible steel ready for teeming. The addition of aluminium, silicon, and other deoxidisers to the ladle is but an indifferent substitute for good melting. Steel made by the basic process would be quite unsuitable for the manufacture of the products referred to in this paper.

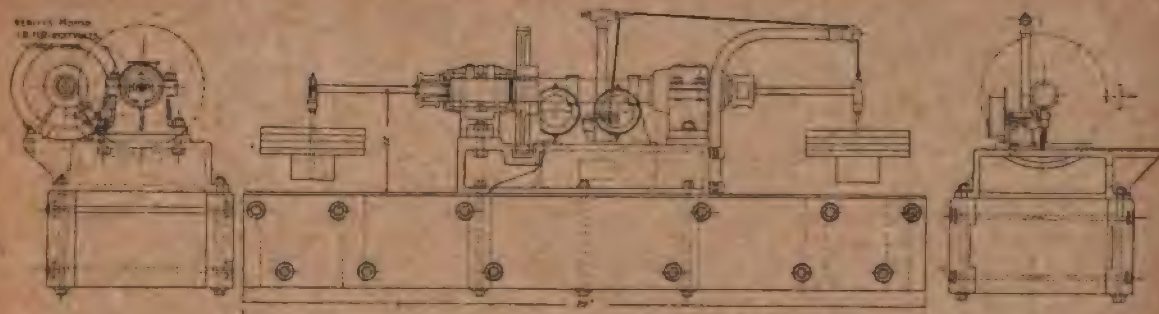
CASTING.

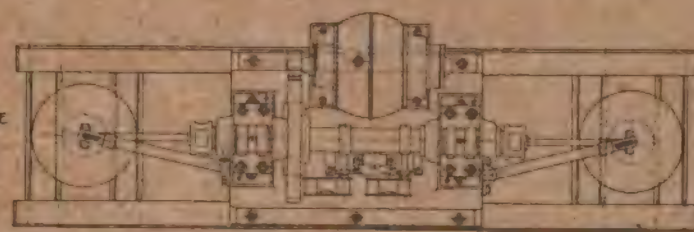
The steel is cast in ingot moulds of circular, octagonal, rectangular, or square forms, depending upon the purpose for which the ingot is required. Circular moulds are rarely used, and then only when the ingots are comparatively short.

The moulds are made of cast iron, with an upper portion of non-conducting material, designed so that the body of the ingot may solidify and be fed by the still liquid head. This head, being the last portion to solidify, serves to include the region of segregation, with the result that the top and bottom of the body of the ingots show very little variation in composition. If the entire mould were lined with non-conducting material, many of the difficulties encountered in making large ingots in chilled moulds would be removed, but there would be the objection that the ingot would solidify more equally over its mass, contraction cavities might be formed in the portion destined for use, while the region of segregation would probably occur there also.

Needless to say, fluid compression is not used. It may seem late in the day to urge objections against the idea, but as in one or two quarters there remains a tendency to see some value in the process, it might be as well to state again the chief objections.

Properly melted steel of the carbon used for products described in this paper contracts in volume when cooling, and, even after the exterior solidifies the liquid interior still keeps contracting, and on solidification forms internal cavities called pipes. If the ingot mould be properly designed this piping occurs in the head, leaving the body of the ingot quite solid. There will be no blowholes in the body of an ingot





DUPLEX VIBRATORY TESTING MACHINE
VICKERS SONS AND MAXIM LTD SHEFFIELD

made of properly melted steel of the class we are describing. If there are any, that particular ingot is unfit for use in high-class work, for the walls of the blowholes would not be welded together at the usual forging or rolling temperature. In dead soft steel there does not seem to be the same objection. An ingot free from blowholes is the proof that the steel was properly melted. We have just seen, however, that if the head of the ingot be properly designed, so that it remains liquid longer than the body, it will contain the region of segregation and also the piping. It may now be asked, of what possible benefit can fluid compression be to properly melted steel? There are no blowholes to be reduced in volume. The pipe is already in a harmless position, while the volume of the head cannot be reduced without danger of the body of the ingot containing the segregation impurities.

The liquid steel itself cannot be reduced in volume by any practicable pressure any more than water can. The specific gravity of "fluid compressed" steel and *well-melted* steel cast in properly designed open moulds is exactly the same. Of course "fluid compression" might serve to mask some of the defects of steel that had been badly melted, by diminishing the volume of the blowholes, but in that case the correct thing would be to scrap the ingot. Fluid compression, therefore, cannot possibly be beneficial to properly melted steel.

FORGING AND ROLLING.

The author does not intend to describe here the details of the forge and mill. He is not aware that they differ materially from the usual practice. It might be mentioned, however, that the correct temperature at which the steel is to be worked in the different departments is secured by the use of pyrometers whenever it appears necessary. The necessary data required for the correct treatment of the steel is supplied by a properly equipped metallurgical laboratory, where micro tests are made, cooling curves and critical points worked out, and photomicrographs made. In the chemical laboratory complete analyses are made of every cast of steel made. The carbons are determined by the colour and combustion methods. As a rule the two methods give very near results. In the testing department the static tests are made on a hundred ton machine, while vibratory tests are made on a specially designed duplex vibratory testing machine. Working with the quality steels made at the River Don Works, the results given by the static test are found perfectly reliable, and the vibratory tests have only served to confirm that opinion. The various plants for the heat treatment of the steel are capable of dealing with masses 100 ft. in length and 100 tons in weight.

A description was then given of typical products, and a number of interesting tables and illustrations were presented. The latter included the duplex vibratory testing machine, shown in the above illustration, and used at the River Don Works. It was shown that in the case of tires a suitable structure has been obtained without any thermal treatment, while the remarkable capacity shown by these tires for resisting wear testifies to the correctness of the principles on which their manufacture is based. In axles, gun tubes, etc., oil hardening is the thermal method adopted; while certain other forgings, possessing as they do a suitable structure when they leave the forge, only require annealing from a comparatively low temperature to relieve any strains set up in forging. Other forgings require heating above the critical range, and rapid cooling in air.

In the course of the ensuing discussion it was generally admitted that the author had contributed a very valuable paper. The question of the fluid compression of steel was taken up at some length by Mr. J. M. Gledhill, who incidentally said that a good deal of nonsense had been talked by many people to the advantage of fluid compression. Some people had said that it improved the steel chemically. Of

course that was ridiculous. Armstrong, Whitworth and Co. (his firm) had never said anything of the kind. Fluid compression was purely a mechanical action—it was where the mechanic came in after the chemist left off. The late Sir Joseph Whitworth—who, he need not mention, was the first to compress steel in the fluid state—was essentially a mechanic, and not a metallurgist, and he brought his mechanical ability to bear. He might be pardoned for saying that his (Mr. Gledhill's) father was associated with Sir Joseph Whitworth for many years on that particular thing, and undoubtedly a great success was made of fluid compression in producing in large ingots what Mr. Johns had said was difficult to get by heat treatment—namely, homogeneity.

Pyrometers Suitable for Metallurgical Work.

AT the Barrow meeting of the Iron and Steel Institute, the suggestion was made that, in view of the growing importance of pyrometers to the steel industry, arrangements should be made to enable members to see the actual working of different pyrometers, in order to enable them to form their own opinions of the relative merits of the appliances available for metallurgical purposes.

The Council readily adopted this suggestion, and appointed a committee, consisting of Mr. R. A. Hadfield, Vice-President, Mr. J. E. Stead, Member of Council, and Mr. B. H. Brough, Secretary, to make the necessary arrangements for the exhibition.

Invitations were sent to all the leading makers to exhibit pyrometers, and to furnish brief descriptions of them, the result being a comprehensive exhibition of these appliances. A report was also presented, including descriptions of the following types :—

(1) Baird and Tatlock pyrometer.
(2) Bristol's recording air pyrometer.
(3) Callendar and Griffith resistance thermometer.
(4) Le Chatelier pyrometer.
(5) Mesuré and Nouel optical pyrometer.
(6) Roberts-Austen recording pyrometer.
(7) Rosenhain and Callendar pyrometer.
(8) Siemens electrical pyrometer.
(9) Siemens water pyrometer.
(10) Uehling pneumatic pyrometer with Steinbart automatic recorder.
(11) Wanner optical pyrometer.
(12) Wiborgh's thermophone.
(13) Zaubitz pyrometer.

A useful list of British Patents for Pyrometers, by H. G. Graves, Assoc. R.S.M., was also included, together with a bibliography.

Mr. Graves remarks that one of the earliest occurrences of the word "thermometer" is in H. van Elten's "Recreation Mathematique," 1626. The word "pyrometer" is of even later origin, but it was in use by Peter van Musschenbroek in 1731, and, following him, by Desaguliers * in 1734, to describe instruments they used for measuring the expansion of metal by heat. In 1754 Smeaton † used the word in a similar fashion. There is not a very marked line of demarcation between thermometry and pyrometry, and naturally endeavours were made at a very early date to measure high, as well as ordinary, temperatures. Perhaps one of the most interesting is divulged in a paper contributed anonymously to the Royal Society by Newton in 1701. This paper, written in Latin, describes a scale of temperatures and a method of determination based on the rate of cooling of a red-hot bar of iron freely exposed to the air. This method was followed up to some extent by others. About 1782 Wedgewood proposed his famous test, which depends on the shrinkage of clay as it is burnt. He was fully aware of the difficulties attendant on the method, but in 1786 was able to show how results, more or less uniform, might be obtained. For the early history of pyrometry, reference may be made to a classified bibliography of physical sciences given by Thomas Young as an appendix to his course of Lectures on Natural Philosophy and Mechanical Arts, which was published in two volumes in 1807.

Before 1850, the patents taken out for devices for measuring temperature are few and far between. The earliest British patent appears to be No. 3,206 of 180[illegible], granted to Stephen Hooper, of Walworth, for "A thermometer or machine for ascertaining the heat of bakers' ovens, and various other purposes." This appliance might be described as a pyrometer, though it only depended on the relative expansion of a brass tube and a wooden rod, yet it was the precursor of numerous devices of similar character and purpose. The next recorded patent is for James Kewley's balanced mercurial thermometer in 1816. After 1850 patents became more numerous, and, at the present time, the yearly average is over a dozen thermometers and pyrometers. An account of them will be found in those volumes of classified abridgments of specifications, entitled "Philosophical Instruments," which are published periodically at the Patent Office.

THE LE CHATELIER PYROMETER. FIG. 1.

The following account was given of the Le Chatelier pyrometer, which appeared to find most favour in the ensuing discussion :—

At the instance of the Royal Physical Technical Institute at Charlottenburg, Mr. W. C. Heraeus, of the well-known firm of platinum refiners at Hanau, undertook the manufacture of a pyrometer according

* "A Course of Experimental Philosophy," vol. i. p. [illegible].

† "Philosophical Transactions," vol. xlviii. p. 598.

to the principle of Professor Le Chatelier, of Paris. The principle involved is the conversion of heat into an electric current and the determination of the degree of heat by a suitable device indicating the electro-motive force of such a current.

A decided advantage which this pyrometer possesses over all others

THE LE CHATELIER PYROMETER. FIG. 3.

consists in its ease of application and convenience in handling, and in the fact that the temperature can be read off at almost any distance from the source of heat. The following is a description of the apparatus and of the method of operation :—

Two wires, one of absolutely pure platinum, and the other consisting of the same metal alloyed with 10 per cent. of rhodium, are fused together at one of their ends in the shape of a small ball (fig. 1), and thus form a couple. This ball generates a slight electric current when heated, and, as ascertained by the Royal Physical Institute by comparison with their celebrated air thermometer, such currents are proportionate to the heat applied. Each element is accompanied by a table of results determined in the same manner.

To prevent injury to the wires by abrasion, injurious gases, and by alloying with other metals, they are usually enclosed in porcelain tubes, a small tube open at both ends being used to insulate the two wires, and a larger one, closed at one end, covering the whole. The Royal Porcelain Factory at Berlin prepares such tubes from an extremely refractory porcelain base, which resists a temperature of 2,920° F. or 1,600° C. These tubes can be made up to 30 in. in length.

The galvanometer used in connection with the pyrometer is of the D'Arsonval type, and is especially adapted to the measuring of thermo-currents. The current is transmitted to an armature, wound in quadrangular shape, through a fine wire of hard metal which does not oxidise. A small spring of the same material acts as a negative. A strong permanent magnet with iron pole shoes constitutes a magnetic field, and an iron cylinder in the centre concentrates the magnetic lines of force. The pointer moves over two scales, one of which denotes the electro-motive force of the current in micro-volts, thus making it possible to check the readings of the instrument, while the second scale gives direct readings of the degrees of temperature. On the side of the cylindrical casing of each instrument there is provided an adjustable thumb-screw, which secures the armature, thus avoiding the breaking of its delicate suspension wire while in transit. This screw should always be carefully secured before moving the instrument.

Adjusting screws in the base allow the instrument to be placed readily in a horizontal position, and a switch on the base of the galvanometer serves for the purpose of breaking the thermo-current. The wire clamp-screws on the galvanometer are marked + and — respectively. The clamp marked + should be connected to the platinum-rhodium wire, and the one marked — to the platinum wire. The platinum is the softer one of the two ends. The knob at the upper end of the cylindrical casing is connected to the scales and permits their adjustment, or, indirectly, an adjustment of the pointer to the zero mark. From the above description the method of the application of the apparatus will be easily understood.

The end of the tube containing the two wires is exposed to the temperature to be measured, and the free ends of the wires are connected to the binding posts on the galvanometer (see fig. 3). Or, if desired, the galvanometer may be placed at any distance from the element, and insulated copper wires may be used to connect both. This wire should be No. 12 American, or Brown and Sharpe gauge for a distance of 300 ft., or at any distance the resistance of the wire used should be no more than one ohm.

As soon as the temperature of the thermo-element has risen to that of its surroundings, the deflection of the pointer along the scales will cease. The temperature surrounding the junction of the element wires with the copper conductors should be 32° F. to give correct readings. Small variations therefrom, up to 65° F., for instance, will scarcely be significant for the application of the pyrometer in ordinary practice. However, it is essential to keep the cold junction of the thermo-couple at freezing-point, if it is necessary to determine the exact temperature of a furnace or other source of heat by direct readings of a galvanometer. The successful application of this instrument in practice requires in some cases special contrivances (see fig. 2), in order to adapt it to the various purposes it is intended for. The galvanometer dial represents the relation between degrees of temperature and millivolts.

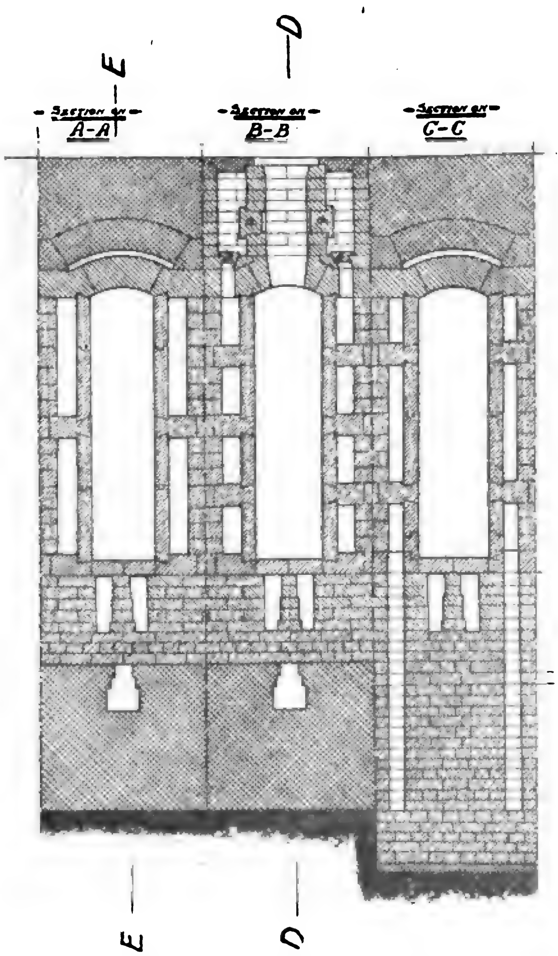
A very interesting demonstration of the working of the various pyrometers was given in the afternoon, and on the following day the

THE LE CHATELIER PYROMETER. FIG 2.

various appliances were discussed at length by Sir Lowthian Bell, Prof. H. Le Chatelier, who spoke in French, Professors T. Turner, H. Louis, and S. O. Arnold, Messrs. R. A. Hadfield, B. H. Thwaite, A. McWilliam, A. Campion, J. M. Gledhill, Enoch James, W. Hanson, and W. Rosenhain.

THE MANUFACTURE OF COKE IN THE HUSSENER OVEN AT THE CLARENCE IRONWORKS, AND ITS VALUE IN THE BLAST FURNACES.

In his paper on the above subject, Mr. C. Lowthian Bell, of Middlesbrough, explained that before the year 1901, though numerous trials of coke made in different forms of patent or retort ovens had been made at the Clarence Ironworks, they had always come back to that made in the old beehive ovens. Every trial had proved that the dirty-looking "cinders" made in the newer apparatus were not as good as what they had been accustomed to. It was now found, however, that with the Hüssener oven they could make a coke giving as good results in the furnace as that made in the beehive.



THE HUSSENER OVEN.—FIG. I.

Sixty of the new ovens were started at the Clarence Works in January, 1901, and the plant is now being doubled.

Section AA, (fig. 1), is through the flues at the ram side; BB, the middle of the oven; and CC at the coke bench end. It will be noticed that between each oven there is a solid brick wall, which carries not only the top arch of the oven but also all the superstructure, leaving little or nothing to be carried by the side walls of the coking chamber. These walls can, consequently, be made very much thinner than is usual in other forms of ovens, and so allow the heat to pass more readily through them. There is, therefore, less consumption of gas for heating the coking chamber.

The horizontal divisions of the flues are built into this wall, and the bricks are dovetailed into the vertical ones, which in their turn are tongued and grooved. This arrangement permits any single oven to be laid off for repairs without interfering with the working of its neighbours, and also allows the vertical walls of the oven to be removed and rebuilt without disturbing the top of the oven in any way.

At the ram engine side the oven is fitted with ordinary fire doors, in order to get up heat on starting, and on each side of the charging-holes there are two loose bricks (marked *a* and *b* in the section BB); by taking these out gas from the ovens is allowed to pass into the flues without going through the washing apparatus. This arrangement also permits the ovens to be used for the manufacture of coke alone, without the by-products. As soon as the oven is in work, and when making by-products, these holes are permanently bricked up. The oven has three charging-doors and one gas off-take.

In regular working, the gas coming back from the various washers, etc., enters on the ram side underneath the floor of the oven into two parallel flues, and between which is a solid brick wall. Each of these flues is connected with the upper flues of the oven, on the same side. The great advantage of this is, that the heat can be the more easily regulated on each side of the oven. The gas, having passed through the bottom flues, rises up to the top of the oven, receiving on its upward course a second, and on turning into the top flue (section C) a third supply of fresh gas. After passing back in the upper flue, the gas falls to the second one (section A), being enlivened by a fourth supply of gas, and then passes through the third flue, enlivened as before, down into the fourth (here it has been found unnecessary to admit any more gas), and so into the waste flue leading to the boilers and chimney.

It will be seen that the flues are really in two separate systems, each heating one half of the oven, both bottom and side. All the gas is forced to pass through every part of the flue, and cannot take a short cut to the chimney. As it is enlivened in so many places, the heating of the coking chamber is very regular, and is entirely under the control of the burner. A large proportion of the air necessary to burn all the gas is admitted in the bottom flues; any further supply can easily be regulated by means of the sight holes, which are fixed close to the inlets. About 70 per cent. of the gas from the coking process is used in heating the ovens, and, having done this, passes under the boilers at a temperature of about 1,500° F., raising sufficient steam, not only to work the exhausters for

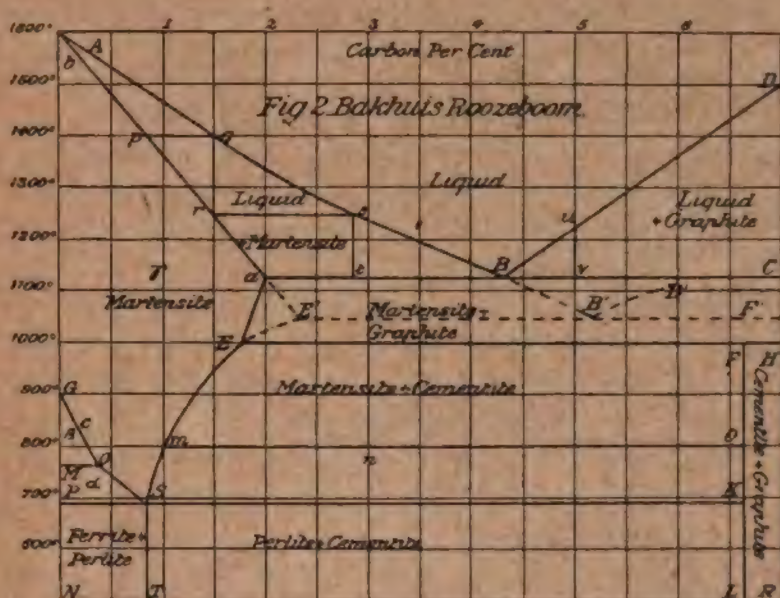
the ovens themselves, but also for the by-product plant, and then leaves about two-thirds of the steam available for other purposes.

This paper gave rise to considerable discussion on the merits of the different coke ovens, the following participating: Dr. W. Hiby, Dr. Rideal, Dr. Dvorkovitz, Messrs. G. Ainsworth, W. Hawdon, J. Riley, F. A. E. Samuelson, E. James, T. Westgarth, B. H. Thwaite, and W. Kirkpatrick.

Dr. Dvorkovitz strongly emphasised the importance of the by-products in estimating the value of the different ovens. Finally, the author invited those interested to go to the Clarence Works and see the working of the Hüssener type for themselves.

The Range of Solidification and the Critical Ranges of Iron-Carbon Alloys.

DR. CARPENTER then read an abstract of the above paper, which dealt with a research based upon a suggestion made by Mr. R. A. Hadfield during his evidence given before the Committee appointed by the Treasury to consider the advisability of establishing a National Physical Laboratory in this country. Mr. Hadfield stated that a determination of the exact melting points of iron and iron-carbon alloys, "commencing, say, with pure iron, then steel with 0·1 carbon, the latter element gradually increasing till white iron, containing $3\frac{1}{2}$–4 per cent. carbon is arrived at," would be of great practical importance. The research has been extended to an investigation of all the evolutions of heat in the alloys from the beginning of solidification down to 500° C.



SUMMARY OF CONCLUSIONS BY PROF. BAKHUIS-ROOZEBOOM.

The results obtained by previous workers in this field have been embodied by Professor Bakhuis-Roozeboom in his well-known paper,* and the authors' work may be regarded as a test of the accuracy of his conclusions, which are summarised in the diagram below, which is reproduced from his paper.

MEASUREMENT OF TEMPERATURES.

The temperatures were measured by thermojunctions. Three of these have been used, one of them being a junction of platinum and platinum rhodium (10 per cent. rhodium), and two being junctions of platinum and platinum iridium (10 per cent. iridium). The diameter of the wires was about 0·5 mm. The two wires were autogenously soldered together in a small oxy-coal-gas blowpipe, and were annealed by glowing with an electric current. The free ends were hard soldered to copper leads. The junctions with the copper were kept at 0° C. by being placed in a box containing melting ice.

DETERMINING THE RANGE OF SOLIDIFICATION.

Description of Furnace.—The melting furnace used was a concentric jet crucible furnace capable of taking a No. 3 Morgan crucible. (A diagram of a vertical section of the furnace is shown in fig. 1.) The gas flame under forced draught enters the furnace casing at J, spins round between the crucible, E, and the furnace wall and issues from a hole in the firebrick cover at H. The thickness of the casing, D, is 5 in. in the narrowest part.

In all cases except that of alloy No. 2, where a magnesia-lined graphite crucible was used to avoid as far as possible the carburising action of the flame, the melts were made in salamander crucibles.

The method of procedure was as follows: From 3 lb. to 4 lb. of material were melted down, the crucible being closed by a lid. The time needed for this varied between thirty to thirty-five minutes for the high carbon irons, and about one and a half hours for the lowest carbon irons. If necessary, slag was then skimmed off, and the mixture well stirred with a salamander rod. The heating was continued about ten minutes longer, the lid was then replaced by a fireclay cover with a $\frac{1}{2}$-inch hole drilled through the middle, and the flame turned out. The thermojunction, E, enclosed in a fireclay tube, closed at the bottom, was inserted through the hole in the cover into the molten

* "Le fer et l'acier au point de vue de la doctrine des Phases." Zeitschrift für physikalische Chemie, vol. xxxiv., p. 437. See also "Journal of the Iron and Steel Institute," 1900, No. II., p. 311.

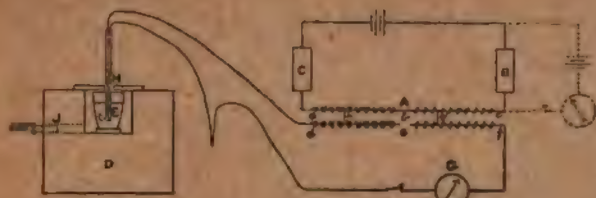
The Range of Solidification and the Critical Ranges of Iron-Carbon Alloys.

1.	2	3	4	5	6	7	8	9	10	11	12	
Alloy No.	Carbon per Cent.	Range of Solidification.		Ar.m.c.	Ar3.		Ar2.		Ar1.		Ar0.	Alloy No.
		Beginning.	End.	Beginning.	Beginning.	Maximum.	Beginning.	Maximum.	Beginning.	Maximum.	Beginning.	
1	0·01	...	...	...	901	900	784	762	...	...	610	1
2	0·02	1504*	1470*	...	900	890	795	762	...	...	600	2
3	0·05	...	...	...	905	884	780	762	...	...	...	3
4	0·12	1504†	1470†	...	894	838	774	762	693	698	600	4
5	0·16	1498†	1465†	...	872	837	771	762	697	693	576	5
6	0·17	1497†	1450†	...	...	...	...	...	...	...	...	6
7	0·24	1492†	1448†	...	890	Merged	...	762	696	693	611	7
8	0·38	1479†	1416†	...	...	...	778	762	700	699	...	8
9	0·47	1432†	...	...	...	...	777	762	...	703	587	9
10	0·53	1473†	1404†	...	...	...	762	730	...	700	617	10
11	0·61	1469†	1334†	...	...	...	780	Merged	Merged	699	593	11
12	0·80	1457‡	1351‡	...	...	...	...	...	...	(704)	...	12
13	0·80	1454‡	...	...	...	...	...	...	...	(695)	...	13
14	0·81	1460†	1351†	...	774	Merged	...	Merged	Merged	706 (705)	...	14
15	0·93	1443†	...	...	774	„	...	„	„	699	587	15
16	1·31	1426†	1286†	883	774	„	...	„	„	(711) 695	600	16
17	1·51	1406†	1244†	911	768	„	...	„	„	(713) 684	587	17
18	1·69	1388†	...	935	774	...	...	...	...	(703) 710	...	18
19	1·81	1383†	...	...	...	...	...	...	...	...	...	19
20	1·83	1383†	1179†	(1015) 1030	783	Merged	...	Merged	Merged	(711) 711	...	20
21	1·97	1367†	...	(1042)	...	...	...	...	...	(710)	...	21
22	2·13	1350†	1110‡	...	...	...	...	...	...	(714)	...	22
23	2·21	1354†	1107‡	...	801	Merged	...	Merged	Merged	714	610	23
24	2·25	1352†	1122†	...	...	...	...	...	...	...	...	24
25	2·25	1348†	1122‡	...	...	...	...	...	...	(714)	...	25
26	2·47	1330†	1134†	1035	801	Merged	...	Merged	Merged	708	622	26
27	2·63	1305†	...	1040	801	...	...	...	...	716	610	27
28	2·67	1306†	...	...	...	...	...	...	...	...	...	28
29	2·74	1300†	1139†	...	...	...	...	...	...	...	...	29
30	2·85	1292†	1139†	1058	...	Merged	...	Merged	Merged	716 (715)	613	30
31	3·03	1277†	1139†	...	777	„	...	„	„	702 (717)	610	31
32	3·20	...	1141†	...	...	...	...	...	...	...	...	32
33	3·42	1238†	1114†	1058	790	Merged	...	Merged	Merged	703 (714)	610	33
34	3·51	1230†	1136†	...	...	...	...	...	...	...	...	34
35	3·87	1190†	1144†	1090	770	Merged	...	Merged	Merged	(716) 716	600	35
36	3·98	1171*	1138*	1087	...	...	...	...	...	713	604	36
37	4·37	1136*——	——1136*	...	...	...	...	...	...	(714)	...	37
38	4·50	1146*——	——1146*	1087	777	Merged	...	Merged	Merged	715	616	38

* Thermojunction M_8 platinum platinum 10 per cent. iridium.
† „ M_6 „ „ „ „
‡ „ M_4 „ „ „ rhodium.

The temperatures in brackets in columns 5 and 11 were obtained by direct cooling. All other temperatures in columns 5-12 were obtained by differential cooling.

Ar.m.c. represents separation of massive cementite.
Ar3 „ change from γ to β iron.
Ar2 „ „ „ β to α „
Ar1 „ „ „ hardening carbon to pearlite carbon.
Ar0 ?



THE RANGE OF SOLIDIFICATION AND THE CRITICAL RANGES OF IRON-CARBON ALLOYS.—FIG. 1.

fluid, care being taken to place it as nearly as possible in the centre and at a distance of about ½ in. above the bottom of the liquid. By this means about 2 in. of the thermojunction wires were immersed. These were insulated from one another by a capillary procelain tube through which one of them was threaded. The cold junctions were placed in an ice-box and the wires from here connected with the potentiometer.

THE CRITICAL RANGES OF THE ALLOYS.

The principle of the method of taking the cooling curves was that introduced by Roberts-Austen and Stansfield, viz., differential cooling between the alloy and platinum cooling under the same conditions. The cooling curves have been taken in air. Under these conditions the surface of the metal becomes oxidised, but not to an extent sufficient to mask the critical changes.

The type of furnace made in the laboratory is shown in fig. 2. It consists of an unglazed porcelain tube 16 in. in length, 1 in. in diameter, C, heated electrically by a coil of nickel wire, 1·5 mm. diameter, carrying about 20 amperes, and insulated by crushed quartz, Q, contained in a wide porcelain tube, E, closed by furnace-ends, D. The whole was contained in a magnesia steam-pipe covering, M. The wire is wound over the central 9 in. of the tube, the distance between the coils gradually increasing from the outside to the centre in order to compensate for the cooling effect of the ends. At the thermal centre of such furnaces there is usually a space of at least 2 in. where, between 1,000° and 600° C., the temperature variation is not greater than about 3° C. A temperature of 1,000° can be reached with about 740 watts.

Cylinders of the alloys, ⅝ in. long and ⅜ in. in diameter, were turned for the cooling curves. The platinum cylinder, A, was drilled with one hole for the insertion of one end of a differential thermojunction, the other end of which was placed in a hole drilled in the alloy, B. The leads, F, from these were hard soldered to copper wires placed in an ice-box, and connected with the galvanometer, G. A second hole was drilled in B for an independent thermojunction connected with the potentiometer. With this arrangement galvanometer G indicates differences of temperature between the platinum and the alloy, while the potentiometer gives the actual temperature of the latter.

The results of the observations on the solidifying ranges of the alloys are given in columns 3 and 4 of the table. With regard to the complete results given in columns 5 to 12, the authors state that—

where possible the beginning and the maximum velocity of heat evolution at each critical change is stated. The former is indicated by the temperature at which the curve begins to change its slope, the latter at which the slope changes from concave to convex. The ends of the critical ranges have not been given, as it appears to us that these depend entirely on the rate of cooling.

CONCLUSIONS.

So far as our results go, they confirm, broadly speaking, the accuracy of Roozeboom's diagram, subject to the following qualifications :—

1. The melting point of iron is about 1,505°.
2. AB is a smooth curve, slightly convex upwards.
3. *a*B is not a horizontal line, but rises from *a* to B.
4. SE may be represented quite as well by a straight line as by a curve.
5. PK is not a straight line, but rises from P to K.

Further, our results indicate that the diagram will be amplified in certain parts when the equilibrium between the various phases has been more fully studied, viz., on account of—

1. The small thermal change at about 790° for alloys with carbon content 0·8—4·5 ;
2. The slow thermal change at about 600° found over the whole range of alloys ;
3. The evolutions of heat at about 900° found in alloys Nos. 35 and 38.

Part of the expense of this research has been defrayed out of the grant to the Laboratory from the Iron and Steel Institute.

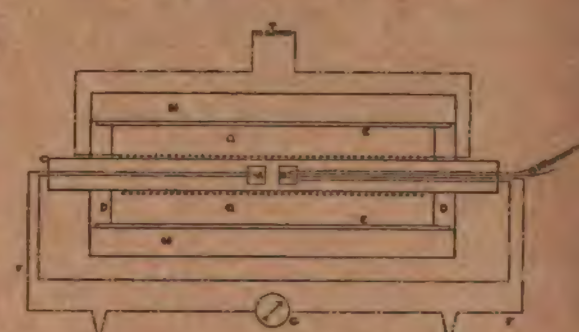
The authors acknowledge with pleasure the interest taken in their work by Dr. Glazebrook, the Director of the Laboratory. They have also to thank Mr. L. F. Richardson for help in much of the work, particularly the chemical analyses, and Dr. J. A. Hafker for advice as to temperature measurements.

Professor Ewing, who criticised the paper at some length, said he had read it with very great interest, as it was one of first-rate importance in settling many points in regard to which there were large gaps in their previous knowledge. He congratulated most heartily the authorities and staff of the National Physical Laboratory on the completion of an exceedingly important and laborious piece of work.

VOTES OF THANKS.

After some further discussion, the proceedings terminated with votes of thanks to the Institution of Civil Engineers for the use of the premises, and to Mr. Carnegie for his able conduct in the chair.

A number of papers were taken as read.

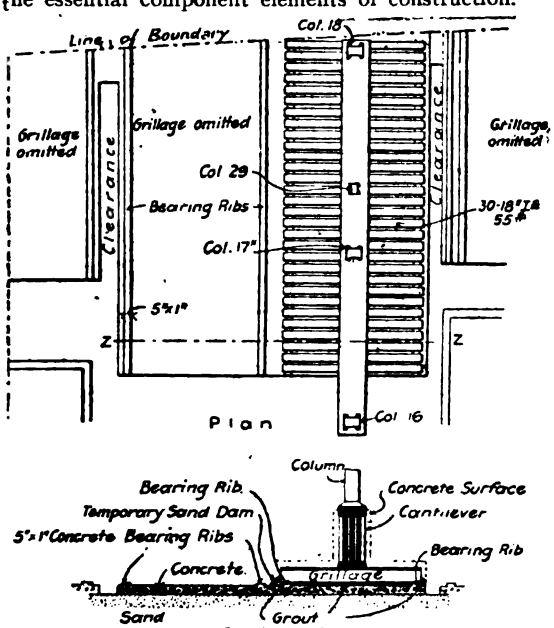


THE RANGE OF SOLIDIFICATION AND THE CRITICAL RANGES OF IRON-CARBON ALLOYS.—FIG. 2.

Mr. B. H. Thwaite on the Steel Structures of America.

NO one who goes to the United States can, in any sense of the word, overlook the lofty steel structures employed in modern business centres. Mr. B. H. Thwaite, during his recent American tour, has been viewing them more particularly in the light of their significance to the iron and steel worker on this side of the Atlantic. His paper on "The Use of Steel in American Lofty Building Construction" brought out the striking fact that the credit of the basis of this mode of construction really belongs to English engineers.

Later and more modern developments, from the date of the early eighties, had their home in the United States, and from amongst the group of workers and pioneers, two men deserve conspicuous mention, one of whom, Colonel Wm. B. Jenney, of Chicago, may be considered to be the father of the American development of the steel and iron frame system of construction in which the steel frame supports everything, the skin or outer walls, the floors, and the roofing. By Jenney's pioneer work steel and iron were made the essential component elements of construction.



Part of Concrete Footing with One Set of Grillage Beams and Cantilever Girder

AMERICAN LOFTY BUILDING CONSTRUCTION.
A modern example of grille foundation construction.
(Fig. 1.)

To another Chicago architect, Mr. W. H. Burnham, credit is due for the novel method of the grille foundation construction system, that safely permitted tier upon tier of storeys to be built, making up an aggregate weight of thousands of tons of superstructure, without danger of serious or irregular settlement.

The first really complete application of the principle of steel frame construction is embodied in the fourteen storey Tacoma building, built after 1886 from the designs of Messrs. Holabird and Roche. This construction constituted an epoch in American architectural history, and in the evolution of the use of steel and iron in building construction. Since this date (1886) the steel frame element has attained supreme importance, architectural features becoming questions of subordinate value.

As the buildings attained higher and higher altitudes, the question of the effect of wind pressures had to be faced, and most ingenious methods of wind bracing, involving a still further increase in the use of steel, have been devised; the earliest serious attempt to structurally face the problem of wind pressures is probably the one embodied in the extension of the Reliance building in the year 1894. The characteristic feature of the system, known as the table-leg wind-bracing method, consists in making each floor rigid in itself, deep plate girders connected by vertical splicing plates to the columns, and not by merely being hung bolted to brackets; these plate girders connecting all the outside columns constitute the origin of the title, the Table-Leg Principle.

THE RATIONALE OF THE SYSTEM.

We know that the use of steel, the conspicuous feature of the system of construction under review, has permitted floors to be superposed over floors to an extent never dreamt of as possible by orthodox masonry constructionists. Now the extension of height involved in the tiers of storeys may reasonably prompt the question, *Cui bono?* The reply can be found in the constant tendency of modern civilised life towards concentration of effort and energy. Every additional floor added to an office, warehouse, or factory, means the duplication, more or less completely, of the ground area on which the building stands. The effect of the steel-frame system, in raising the normal number of storeys from five to twenty, is equivalent to the addition to the business area of Manhattan Island, New York, of some 200 acres of habitable land—probably representing an increased yearly rental of 1¾ millions sterling. Although the highest qualification in favour of the steel-frame system of construction is embodied in the fact that it has extended the safety limit of building height by an additional twenty storeys, the system is now being applied to structures of the height usual in Europe, and within the limits controlled by building regulations of European and British cities; * but the author trusts that his

* *An Essential Condition of Success.*—As a rule all the steel-frame buildings erected under the supervision of the expert engineers are designed with most conscientious care. The author was surprised with the thoroughness with which all the proportions were calculated to satisfy exigencies of variable loads, to secure safety from settlement, from fire effects, and from the influences of wind pressures. The methods of calculation and the average precautions taken would satisfy the most cautious of British engineers; yet at the same time clauses safe-guarding the public against the jerry-builder of steel structures ought to be inserted in the building regulations of the cities of the United States. The steel-frame system of building, of so much interest to iron and steel makers, has suffered by the action of unscrupulous builders who are sufficiently dishonest to prefer to paint imitation rivets and use girders of inadequate strength. Such unscrupulous work has already proved fatal to men's lives in the United States, and constitutes a warning for those responsible for the framing of the building regulations of our cities.

explanation of the rationale of the system will tend to induce the Iron and Steel Institute to use its influence in removing the British and European restrictions that prevent the full advantages of the new system from being secured.*

The increase of office accommodation by the construction of the lofty steel-frame buildings has brought down the rents of offices and warehouses; for example, the charge for offices in the old buildings of 12s. per square foot has been reduced to as low as 6s. a square foot, a price that includes conveniences and advantages that did not exist in the old offices.

It will be realised that a substantial reduction of rent, along with the additional and splendid advantages and conveniences provided, makes the new system a positive boon to the City worker. That the system may also be profitable, as it deserves to be, is proved by statistics.

AN IMPORTANT FIELD OF APPLICATION.

The field of application of iron and steel in the steel-framed building operations has assumed very important dimensions. It is one that is rapidly extending, and that the effect of the irresistible law of the survival of the fittest will become evident here, will be the opinion of metallurgists and engineers who have the privilege of the experience of seeing the systems for themselves in the great cities of the United States.

The proportions of the steel-framed building demand for steel in the United States are increasing. It may with sufficient accuracy be assumed, that on the average of the last five years some 200,000 tons of steel and iron are absorbed in steel-frame construction in the United States per annum.

In this new structural development the American iron and steel industry has indeed found a friend. Shall the friendship be extended to cover, in its benefits, the iron and steel workers of Europe and Great Britain?

The mechanical equipment of a first-class steel-frame structure includes the provision for ventilation heating, fire protection, refrigeration, electric lighting, telephone, and electrical services—power provision for lift or for elevator service—all requirements involving in some measure the use of steel and iron.

IMPORTANCE OF THE KNOWLEDGE OF THE SYSTEM ON THE PART OF THE IRON AND STEEL MANUFACTURER.

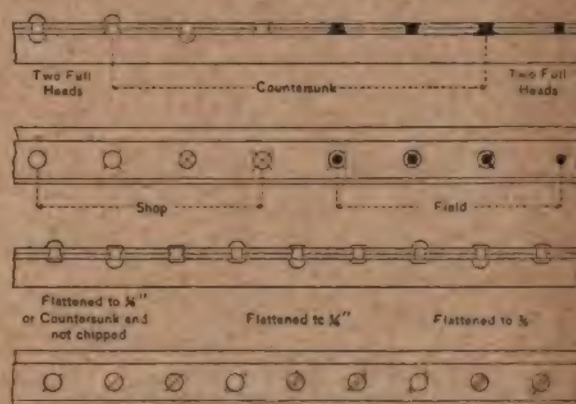
In the United States the new system has practically revolutionised the professional constructional organisation, the engineer, steel-framework designer, and the ironworks have partially displaced, for the constructional services, the architect and the timber-yard. The engineer and the architect have joined forces with the happiest results—science and æsthetic art being thus associated. The new system of construction has not been adopted in Great Britain, except in a very tentative way, and for buildings of some four to five storeys only.

An examination, whenever an opportunity occurs, of the details of the steelwork structural system will soon convince iron and steel makers that they will probably benefit by becoming interested in watching and aiding the new development, which puts their product on such a high plane of utility.

* The height of buildings is restricted in some of the American cities, although in others a man may build any structure he pleases on the lot he owns. There are no laws respecting light, except for certain classes of buildings.

The steel-framed structural system permits a considerable part of the mechanical work, involved in fitting together the different elements, to be carried on at the iron or steel works.

In the United States the mechanical work of fitting is divided into two branches, differentiated by the terms shop and field work.



AMERICAN LOFTY BUILDING CONSTRUCTION.

Conventional signs for riveting shop and field work.
(Fig. 2.)

The diagram (fig. 2), shows the graphic method of defining which is shop and which is field work. The columns, brackets, gussets, and other steel support attachments are as far as possible riveted up before they leave the manufacturer's works, girders are cut to length, and all holes cored, drilled, or punched; in fact, every part of the work is designed to secure rapidity in working constructions with the minimum degree of transport, etc. When the steel columns and girders arrive at the site,* they are then ready for immediate attachment, the result is a speed of erection that to Europeans appears to be little short of marvellous. The examples presented of the rapidity of construction are sufficiently convincing; a twenty-storey building may be erected in less than six months; buildings have been erected at the rate of one storey complete in a fortnight.

Other papers, taken as read, were as follows: "The Thermal Efficiency of the Blast Furnace," by W. J. Foster, Darlaston; "The Synthesis of Bessemer Steel," by F. J. R. Carulla, of Derby; "The Effects of Slowly Applied and Suddenly Applied Stresses," by Pierre Breuil (Paris), Carnegie Research Scholar; "The Plastic Yielding of Iron and Steel," by Walter Rosenhain, B.A., Birmingham; "The Influence of Temperature on Steel and Iron Castings," by Percy Longmuir (Sheffield), Carnegie Research Scholar; and "Troostite," by Henry Cook Boynton, S.M. (Harvard University).

* Each storey bears its own weight.

SOUTH AFRICA AS A MARKET FOR BRITISH TRADE.

MR. HENRY BIRCHENOUGH'S OPINION AS A BUSINESS MAN.

IN the course of a discussion which followed an excellent paper on "The Regeneration of South Africa," read by Mr. Ben. H. Morgan before the Society of Arts, Mr. Henry Birchenough offered a few remarks as a business man. He said the one thing they ought to pray that South Africa might be delivered from, was the politician.

If the English people could forget South Africa for three or four years, and leave the very competent and able men who were there to work out its destiny, it would be the very best thing that could happen to that temporarily unfortunate colony. What South Africa wanted was business administration, business gifts, and business talents, to drag it out of the rut into which it had fallen.

ITS EXTRAORDINARY COMMERCIAL IMPORTANCE.

He had never found that the ordinary citizen really understood the extraordinary commercial importance of South Africa to this country. It came as a matter of surprise to most people to find that, during the last two years, South Africa had been the second best customer which England had, and had taken more of the manufactures and products of the United Kingdom than any other country, except India. Although it was true that during the last two years there had been a certain amount of over-trading in South Africa, he was sanguine enough to believe that that was only a temporary phenomenon. If instead of talking in clubs and imagining all kinds of things, they would go to South Africa and see for themselves, they would form just conclusions.

MINERAL RESOURCES, ETC.

It was extremely difficult to avoid using language which sounded exaggerated with regard to the mineral resources of our new colonies. At present the gold industry had hardly been touched, and, besides this, there were coal and iron in enormous quantities, and diamonds both in the Orange River Colony and in the Transvaal. The mineral wealth of those colonies was almost boundless, and the expenditure required upon public improvements was absolutely enormous. The Boer Government never did anything whatever to make life in their towns even bearable. In Johannesburg, a large prosperous city, there was not even to-day one single presentable drain. Every single drop of slop water was carried away in buckets every night at the cost of £200,000 a year. The same state of things in a less degree existed in many of the large towns in South Africa. And then agriculture was comparatively undeveloped, indeed there was no branch of human enterprise which was not calling loudly for the investment of capital for its development.

THE LABOUR PROBLEM.

What stood in the way? It was one single difficulty, and that was the want of unskilled labour. Just before Easter he was stopped by a procession of British workmen trudging along to Hyde Park in order to demonstrate their desire that South Africa should be still further starved of labour, and, if what those British workmen demanded took place, the result would be that many of themselves engaged in engineering and similar trades, would have to be turned off from their work. When he saw them he did not know whether he felt more saddened by the generosity of their intentions or by the folly of those persons who had driven them into such a demonstration. It was needful to bring before the minds of the English people the fact that South Africa represented for Great Britain a most remarkable market for British industrial products. Whereas the other markets which took British goods were gradually drying up under various influences, we had in South Africa an *almost virgin market for the expansion of British trade*. He was more sanguine than the reader of the paper with regard to the opening for British products in South Africa.

HOPEFUL INDICATIONS.

He admitted that there had been an enormous extension of foreign trade in South Africa, but when the returns were examined it would be found that that trade consisted to a very large extent of articles with which England could never hope to compete, such as food stuffs, building materials, and other things which Great Britain herself imported from foreign countries. The rapid expansion of the trade in imported food stuffs was due to the fact that since the war South Africa had been almost entirely unable to feed itself. Every article which the builder required, except brick and stone, had to be brought into South Africa by sea and by rail, and even the mealies which constituted the main food of the Kaffirs had had to be brought from Argentina instead of being grown in the colony. Nothing gave him so much pleasure while he was making investigations in South Africa as to find to what a large extent the different parts of the British Empire were beginning to supply each other's needs. A large proportion of the bread stuffs eaten in South Africa came from Australia; butter was obtained from Australia; and frozen meat was obtained from New Zealand and Australia; and we might look forward to the different parts of the Empire increasingly supplying the needs of South Africa. One of Mr. Morgan's recommendations was that a permanent trade commissioner should be appointed in South Africa to assist and advise British traders. The Imperial Government had already appointed official correspondents in South Africa, and these gentlemen were at the service of any manufacturer in this country who chose to communicate with them either directly or through the Board of Trade. These correspondents were already frequently sending home what in colloquial language were called commercial "tips" which, he felt sure, would be of very great value to those persons who made use of them.

WHAT THE LABOUR QUESTION REALLY MEANS.

He thought that there was a great deal of confusion in the public mind with regard to the question of Chinese labour. There seemed to be an idea that special measures were required for the assistance of the gold mining industry, and of that only. The fact was that the labour problem which South Africa had to solve was one which concerned all the industries. The moment the gold mines were supplied with labour, other industries would begin to develop in every direction. The gold question was the one which lay at the root of all other developments. The interests of the Transvaal and the Orange River Colony were identical with the interests of the maritime colonies of Natal and the Cape, and the trade of the maritime colonies, which were the sea-gates of South Africa, was dependent upon the inland colonies.

THE SOCIETY OF ENGINEERS

HOLDS ITS JUBILEE MEETING

AT the Jubilee Meeting of the Society of Engineers, held at the Royal United Service Institution, Whitehall, on Monday evening, May 2nd, Mr. D. B. Butler, President, in the chair Mr. Perry F. Nursey, Past President and Secretary, read a "Jubilee Retrospect," being a brief history of the Society from its inception to the present time. After referring to his election as a member of the Society in 1858, four years after its inauguration, and to the fact that in one capacity or another, honorary or otherwise, including that of President, he had worked for it without a break ever since he was elected, Mr. Nursey proceeded to point out that although the Society was established in 1854, it was not then known by its present name. For the first three years of its existence, it was called the Putney Club, having been founded by students of Putney College, an institution which formerly existed for the education of engineers. The founders were Robert Monro Christie, Henry Palfrey Stephenson, and Alfred Williams, the latter of whom held the office of Honorary Secretary and Treasurer to the day of his death in 1894. The members used at first to meet periodically at the offices of Mr. Christie and Mr. Stephenson, when various points of engineering practice were introduced and discussed, on the lines of the topical discussion system, now so largely in vogue in the United States and which was successfully adopted upon one occasion last year by the Society. In 1855, however, the formal reading and discussion of papers was commenced. In course of time a set of twenty-four rules was framed, and out of these from time to time have been evolved the comprehensive rules and bye-laws by which the Society is now governed.

At the Annual Meeting of the members of the Putney Club held on December 7th, 1857, Mr. Nursey stated that the Society was re-christened by its present name —"The Society of Engineers." At that date the number of members had increased to 54 from 25, which latter was its strength at the close of 1855. This increase of numbers necessitated a larger meeting room, and No. 4 Committee Room in Exeter Hall was taken for that purpose. In course of time the Committee Room proved too small, and the Lower Hall was engaged for the meetings, which were held there for some years. A prominent feature of the year's work in 1858 was the awarding, for the first time, premiums of books for papers read during the year, the first recipients being Mr. James Amos for a paper on "The New Hydraulic Lift of the Thames Graving Dock," and Mr. John Glynn, Jun., for a paper on "Dr. Clarke's Water Softening Process." The year 1861 was marked by the holding of a conversazione in the lower hall, Exeter Hall, on June 11th, which function was successfully repeated in 1863. The latter year marks the introduction by Mr. Williams of vacation visits to works of engineering interest, the first visit being to the Southern Outfall of the Main Drainage Works. Later on in the year the Northern Outfall was visited.

INSTITUTION OF HONORARY MEMBERS' CLASS.

The year 1863 witnessed the institution of the class of honorary members, although none were elected until 1865. Amongst the earliest honorary members were Lord Playfair, Sir William Fairbairn, Sir John Herschel, Sir Joseph Whitworth, Dr. Percy and Professor Macquorn Rankine. In 1864 the question of issuing certificates of membership was discussed, but their issue was not then considered desirable. They were, however, adopted in 1867 in their present form. Coming to later times, Mr. Nursey observed that the year 1900 merited notice as being that in which the present honorary secretary and treasurer, Mr. George Burt, presented the Society with the handsome badge of office in gold and enamel worn by each successive President.

MEMBERSHIP.

Proceeding to generalities, Mr. Nursey next touched upon the membership roll and the useful work done by the Society during its fifty years of existence. Referring to the figures of membership of the Society, in its early days, he said that the rate of subsequent progression had been somewhat irregular. In 1893 the Society touched a maximum, when it had a record number of 522 members. After that it declined a little, but in 1902 the previous record was beaten by one, the membership standing at 523. Last year witnessed a marked advance upon that, the Society numbering 540 members at the close of the year. "And," said Mr. Nursey, "we are still on the increase, inasmuch as during the present year we have, so far, elected eight new members, which, with the seven to be balloted for at the close of the present meeting, practically brings our numerical strength to 555 members and associates."

THE WORK OF THE SOCIETY.

As regards the useful work done by the Society, Mr. Nursey said: "I find that we have published forty-four volumes of Transactions, including that for the past year. They contain 10,124 pages and embody 371 papers, illustrated by 588 plates and 204 smaller engravings. In some cases, the same author has given us several papers. Amongst these may be mentioned Mr. Baldwin Latham, with eight papers, Mr. Arthur Rigg, with eight papers, Mr. Vaughan Pendred, with six papers, Mr. C. J. Light, with six papers, Mr. Henry O'Connor, with four papers, and myself with twenty-two papers, including in all cases, except that of Mr. Light, a presidential address."

"Such then, in brief," said Mr. Nursey in conclusion, "is the record of the Society for the first half-century of its existence. To me it is a record of pleasant memories and associations—of memories of those with whom I have worked shoulder to shoulder, but who have passed away, and of associations with those who have taken their place, and with whom I am now working to promote the general interests of the Society, which work to its executive has ever been, and still is, a labour of love. I refer here to our members of Council, who are the worthy successors of our worthy founders, Henry Palfrey Stephenson, Robert Monro Christie, and Alfred Williams."

THE LIMITATION OF DEPTH IN COAL MINING.

BY

JAMES A. ASHWORTH, M.E.

COMPARATIVELY few people who sit before a cheery coal fire during the cold months of the year have any idea of the serious depletion of our coal resources which is taking place day by day, and whilst grumbling at the price they have to pay for this necessary article of comfort, they do not recognise the fact that the expense of winning coal is increasing as the depth increases, and that it is not at all likely that coal can ever again be purchased at the very low price at which it was offered only a few years ago. Nor do the bulk of people realise what a huge hole is being made in the earth year by year by this depletion, which in 1902 amounted to more than 227,000,000 tons, without reckoning a waste of from 10 to 50 per cent. in working. It has been stated that this huge yearly reduction in our coal resources has already affected the iron, steel, and coal industries of Britain, as evidenced by the reduced expansion of these industries.

The Royal Coal Supplies Commission has already issued a first report in three volumes, in which (1) the limit of depth in mining, (2) the minimum thickness of workable seams of coal, (3) the waste in working, have been investigated, and from this we are able to recognise to the full the seriousness of the position.

This Commission was appointed on the 28th of December, 1901, to inquire into the extent and available resources of our coal fields, the rate of exhaustion, economies in use, effect of exports, and the time for which the supply will be available at a cost not detrimental to the general welfare, the reduction of cost by cheaper transport, avoidance of waste by better means of production, or through change in the terms and provisions of mineral leases, and to decide whether the mining industry of this country is maintaining its competitive power with those of other countries.

TEMPERATURE OF DEEP LEVELS.

Expert witnesses have placed the limit of depth below the surface at which coal can be mined at 4,000 feet, not because there is no coal at a greater depth, but because the physical and sanitary conditions are such that the human machine cannot adapt itself to them. The majority of people probably think that the depth at which coal can be worked is ruled by the capacity of our mechanical engineers to devise means of bringing the coal economically to the surface, but at present this is not so, as there are other and more potent difficulties which must be surmounted before our engineers are called upon to produce stronger hauling and lifting machinery. The principal difficulty is that of temperature, and this part of the Commissioners' enquiry has elicited most interesting evidence on the progressive heat of the strata as we penetrate deeper into the crust of the earth. Attempts have been made to formulate rules by which this increase of temperature could be calculated beforehand, but these have not been successful. In Lancashire the rate of increase varied from one degree in 40 ft., 1 in 55 ft., 1 in 70 ft., up to 1 in 80 ft., which figures do not of course agree with the generally accepted rule of 1 degree in 60 ft; in South Wales, the rate of increase varied even more than in Lancashire, viz., from 1 degree in 35 ft., to 1 degree in 108 ft., and it was also shown that the average geothermic degree is more than 60 ft. for moderate depths, and considerably more for greater depths.

Supposing, therefore, that a temperature of 98 deg. F. represents the extreme temperature of the air in which a collier can perform his daily labour, the limit of workable depth may be extended further than the present assumed limit of 4,000 ft.

There is, however, another factor which cannot be left out of the problem, viz., a certain increase of temperature due to the additional depth of the atmosphere, which has been estimated at one degree for every 100 vertical feet, and added to this natural heat, we have other heats caused by oxidation, friction of the strata when set in motion by the extraction of coal, heat given off by safety lamps, and men and horses, making a total which varies in different mines under every head excepting only the first. Consequently, in some cases the heat of the air exceeds that of the strata.

The possibility of mining coal at great depths is, however, unalterably fixed by the degree of heat which a miner can endure when hard at work, and medical authorities have placed this factor at 98 degrees F., when the air is saturated with moisture, but practical experience has proved that a much lower temperature, viz., 84 deg., when saturated with moisture, is very much more oppressive and enervating than dry air having a temperature of 94 deg.

SPRAYING AND WATERING.

A dry mine is, as a matter of course, a dusty mine, and therefore if the spraying and watering recommended by the Coal Dust Commission as necessary for the safety of a mine, is to be thoroughly carried out, the limit of mining will be reached long before a depth of 4,000 ft. is attained; in fact, such a limit has already been attained, and to enable the colliers to continue working, they are now being supplied with the driest air possible. Artificial means for cooling the air may also become necessary, but at the present time no such means are in use. Water sprays have been recommended and tried, and abandoned for two reasons; firstly, because the effect is only local; and, secondly, because it is absolutely imperative that the air of the mine shall be kept dry.

Three at least of His Majesty's Inspectors of Mines having tacitly accepted these practical facts, and acquiesced in the disuse of sprays and other watering contrivances, the miners in our deepest collieries have been enabled to continue their useful work. It does not appear probable, however, that this modification of ordinary mining practice will be sufficient in itself to enable our miners to continue working coal at any considerable depth below 4,000 ft., without the provision of some ready and cheap method of cooling the large volumes of air which are required to ventilate the workings of all modern collieries, and, therefore, the Coal Supplies Commissioners appear to have ample justification for fixing the limit of depth at 4,000 vertical feet below the surface.

LONDON'S LATEST DOCK.

FACTS ABOUT THE NEW GREENLAND DOCK OF THE SURREY COMMERCIAL DOCK COMPANY, TUESDAY, MAY 3rd, 1904.

THE opening of the new Dock at Rotherhithe for the reception of shipping, forms a notable addition to the dock accommodation of London, and is a matter of exceptional interest at the present time when all questions relating to the improvement and development of the port are engaging so large a share of public attention.

THE FIRST PUBLIC WET DOCK—1696.

The new Greenland Dock forms part of the Surrey Commercial Dock System, which occupies the greater part of a peninsula on the south side of the Thames, lying between the Lower Pool and Limehouse Reach. Some interesting historical associations cluster around the site of this newest of London's Docks. Here, according to a tradition supported by the authority of Stowe, was the beginning of the trench or canal which Canute made to avoid the bridge when he brought his fleet up the Thames to lay siege to London; and on this spot at the close of the 17th century, was constructed the first public wet dock in the United Kingdom. This dock was known as the Howland Dock, and was so named after the daughter and heiress of Sir Giles Howland, of Streatham, who married the Marquis of Tavistock, the son of the ill-fated Lord William Russell. A petition was presented to the House of Lords in February, 1695, on behalf of the Marquis and his wife, who were minors, praying leave to bring in a Bill to enable them "to raise and lay out monies for making a Wet Dock at Redderiffe." This Bill was read for the first time on Sunday, the 15th February, 1695, and received the Royal assent on the 10th April, 1696. The importance of this Dock to the shipping of the time is thus quaintly recorded by a contemporary chronicler:—

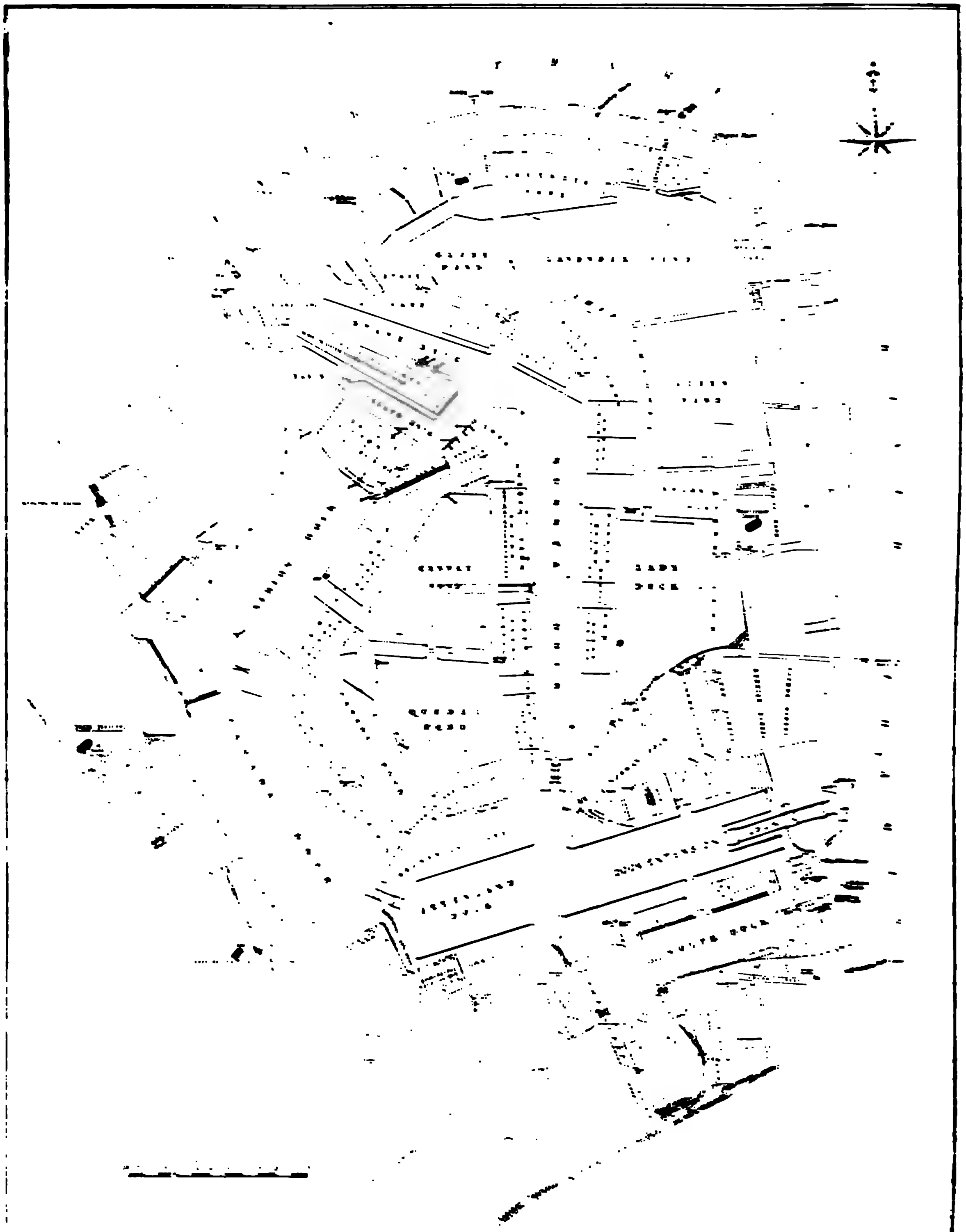
"This dock has been found a very safe repository for ships, which was fully proved in the terrible and violent storm which happened on the 27th November, 1703, when, by the extremity of the winds, all the ships in the river which rode either at chains or their own moorings were forced adrift, and confusedly driven on the north shore, where some were lost, and most received great damage. Then of all the several ships deposited in this Wet Dock there was only one slightly injured in the bowsprit."

Such are some of the associations which connect the oldest Dock in the Kingdom with the newest Dock, linking the 17th and 20th centuries—the latest achievements of dock engineering with the earliest recognition of the need for docks as "a safe repository for ships."

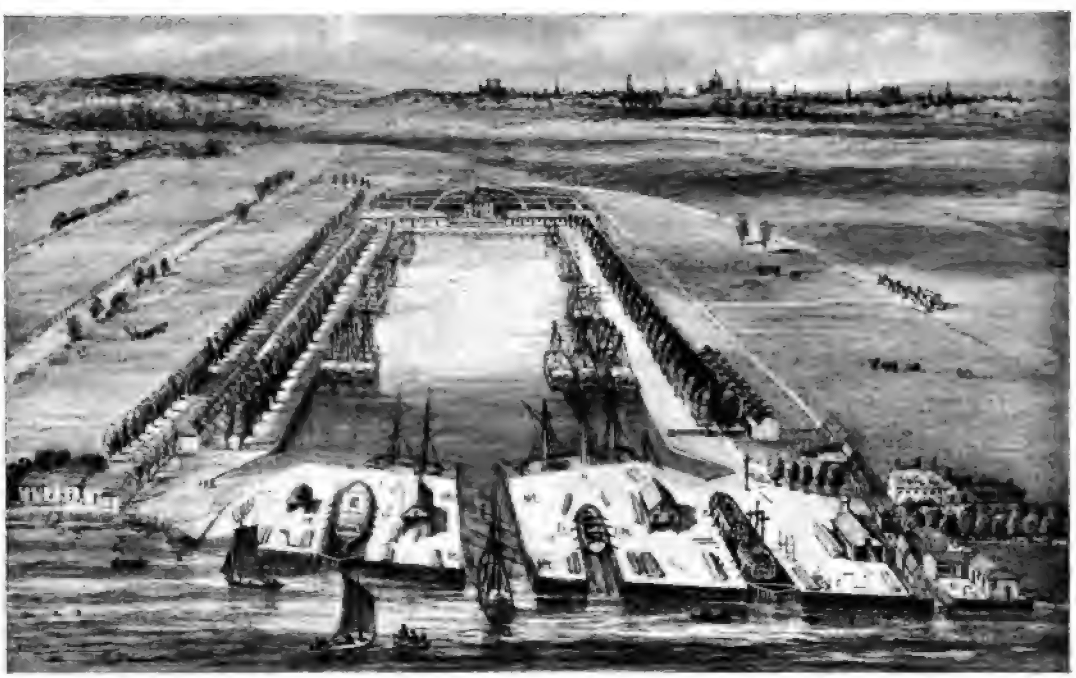
SURREY COMMERCIAL DOCK SYSTEM.

From this small beginning, accounted a great enterprise in its day, has been evolved the Surrey Commercial Dock System, which covers 370 acres, or, if we include its adjunct, the Surrey Canal, 450 acres. It comprises besides the deep water docks, having an area of upwards of 100 acres, extensive ponds for the storage of floated timber. It has nearly six miles of quays, and over eight miles of paved and macadamised roads. There is piling ground for wood goods of 200 acres, and about 50 acres are occupied by substantial sheds or warehouses which have been erected to meet the growing demand of the wood trade in recent years for such accommodation. A new group of sheds is in course of construction, and the combined storage capacity of these sheds is 65,000 standards, or 214,000 loads. There are also nine granaries, capable of storing about 280,000 quarters of grain, and warehouse for general produce.

These Docks are mainly appropriated to the wood and grain trades. They may be said to be the great emporium of the London wood trade, and some idea of the magnitude of this business is indicated by the fact that last year the total quantity of wood goods received for storage in these Docks amounted



THE NEW DOCK.
Locking in the first steamer, the *Melanie Groedel*.



HOWLAND GREAT WET DOCK, IN THE PARISH OF ROTHERHITHE.
The first public wet dock constructed in the United Kingdom.

to 780,000 loads.* The Company have had the good fortune to attract and retain the business connected with these indispensable commodities—grain and wood—and the growth of London, with its ever-increasing demand for foodstuffs and building materials has necessitated a corresponding development of the Docks devoted to this important section of London's commerce.

The Surrey Commercial Docks have the great advantage of being in close proximity to the centre of London's trade. They are within a distance of two miles from London Bridge, and about 1½ miles from the Tower Bridge, and are immediately adjacent to the new Tunnel which the London County Council are about to construct to connect the populous districts on the north and south sides of the river. To its geographical position and its consequent saving of expense to merchants in time and money for the cartage and distribution of their goods these Docks doubtless owe some of their prosperity.

THE NEW DOCK.

The new Dock and Entrance may be said to mark the completion of a long and costly series of improvements undertaken by the Company. Long before the question of the improvement of the Port attracted the general attention, the Directors had foreseen the necessity of bringing their Dock system thoroughly up-to-date, so as to meet the most modern requirements of the trades in which they are interested. They applied to Parliament for the necessary powers and the Dock Extension Works were begun in 1894. These Works comprise the new Greenland Dock, the construction of a Lock and Entrance from the river, a communication passage from the south-east corner of the Canada Dock into the new Dock, the extension of the Russia Dock southwards, and the construction of a passage from that Dock into the new Dock, a new canal lock and the formation of a basin by widening the Canal. The new Dock is 2,250 ft. in length by 450 ft. in breadth, covering an area of about 22 acres with quays 5,380 ft. or upwards of a mile in length. It is connected throughout with the other parts of the Dock System by communication passages through the Canada and Russia Docks. The Entrance Lock is 550 ft. in length, 80 ft. in breadth, and has a depth of water on the sill of 33 ft. below T.H.W. Here it may be remarked that the new Dock will not be accessible to vessels of the largest class it is designed to admit until the necessary further deepening of the river shall have been carried out.

The original plans for the works were prepared by the late engineer of the Company, Mr. J. A. McConochie, M.Inst.C.E., who unhappily died before any substantial progress with the works had been made. The Company then decided to secure the advice of the highest engineering authority, and entrusted the supervision and control of these important works to the eminent engineer, Sir J. Wolfe Barry. Having in view not only the present, but the possible future requirements of the trade of the Port, the Directors, with the advice of Sir J. Wolfe Barry, modified and extended their original plans, increasing the proposed width of the Dock by 100 ft. and the length and depth of the Entrance Lock. As is usual in works of this magnitude the original estimate of the cost has been considerably exceeded, and the Company have spent nearly a million sterling on these improvements of their system, which have been nearly ten years in hand. The contract for these works was let in two sections, the first of which was finished in 1897, the second section, now completed, was begun in 1898. Messrs. S. Pearson and Son, Ltd., secured the contract for the whole of the works, which they have carried out in a manner worthy of their great reputation. The construction of the lock gates, bridges, and hydraulic machinery was entrusted to Messrs. Sir W. G. Armstrong, Whitworth and Co., whose name is sufficient guarantee for the excellence of their part of the work.

The Dock Companies have in recent years been exposed to a great deal of adverse criticism, but it cannot fairly be said that the Surrey Commercial Dock Company has been slow to recognise the altered condition and development of the trades with which they are concerned, or have failed to meet the demands for up-to-date accommodation and facilities. They have now the satisfaction of knowing that their object has been accomplished, and whether the wisdom of Parliament permits them to retain the management of the undertaking which in their hands has grown to its present dimensions, or whether the Docks are to pass from them to the control of a newly-constituted public authority, it must be said that the Surrey Commercial Dock Company have responded to the demands of the shipping and trading interests for dock accommodation adequate to their needs, and that their foresight and enterprise have contributed largely to increase the facilities of the trade of the Port of London.

* This quantity would serve to lay a roadway 35 ft. wide by 6 in. thick from the Lizard to Berwick, would make a bridge across the Atlantic to New York over 12 ft. wide by 2 in. thick, or put a girdle round the Equator 3 ft. 6 in. by 1 in. thick.

ELECTRIC DRIVING IN FACTORIES.

WE have already described * the contents and plan of the new work on Modern Electric Practice, edited by Mr. Magnus Maclean, M.A., D.Sc., and issued in six volumes by the Gresham Publishing Company. By the courtesy of the publishers we are able to reproduce two of the full-page plates which, with innumerable smaller illustrations, form such an attractive feature of these volumes.

One of the most suggestive chapters included in the two volumes which have already been issued deals with applications of the electric motor, the author noting that one of the best fields for electric driving is to be found in factories. Indeed, he says, there are probably few, if any, operations performed by gas or steam-engines which may not be accomplished, at least with equal efficiency, by the electric motor, and in the majority of cases better all-round results are obtainable.

The most apparent advantages of an electric drive for such purposes are stated as follows :—

(1) Good speed regulations for varying loads.
(2) High efficiency at all loads.
(3) Economy of space occupied by the motor.
(4) Economy in prime cost of power.
(5) Economy in transmission and in application.
(6) Absence of heavy foundations.
(7) Freedom from vibration, noise, or smells of any kind.
(8) Attendance reduced to a minimum.
(9) Skilled attention unnecessary, except for occasional surveys.
(10) Risk of breakdown comparatively slight.
(11) Wearing parts few in number and cheap to replace.
(12) Small capital outlay.
(13) Small consumption of energy, because the power is automatically adjusted to the load.

This list by no means exhausts the "points" of an electric drive ; it merely indicates the chief features.

For factory purposes it does not often happen that motors of less than ½ h.p. are required, and more frequently machines of from 1 h.p. to 15 h.p. are found to be the most suitable. In laying out a new factory, or in altering an established one from gas or steam to electric driving, there are several broad issues to be considered and weighed very carefully before the scheme be decided on.

First, the operations to be performed should be considered. Whether they are mainly continuous or intermittent ; whether all the plant must be kept running ; or whether any part of it may be shut down for periods without seriously affecting the economy of the operations, etc.

* PAGE'S MAGAZINE, May, 1904, page 478.

For example, in a boot factory the hand-work and machine operations are generally arranged so as to balance only when all the plant is in use. In an engineer's shop or a printing establishment, on the other hand, it is generally absolutely necessary to run separate machines or groups of similar machines independently. An efficient scheme will obviously include suitable arrangements to meet these several requirements.

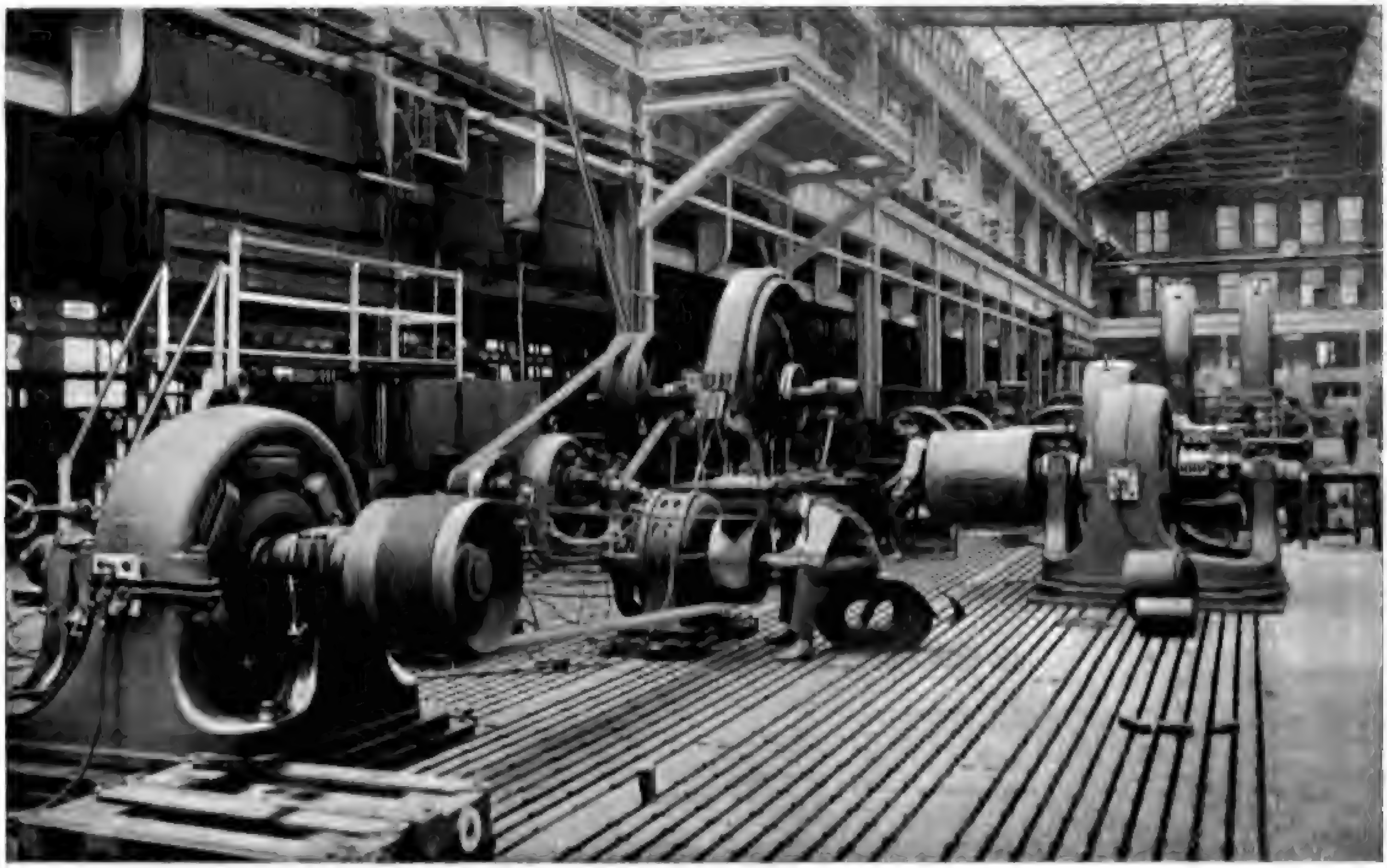
It thus happens that in some instances one or two large motors may be conveniently arranged to drive a small factory through line shafting more economically than a number of smaller motors connected to separate drives. In other cases, such as printing establishments, it is usually found more economic, in spite of the increased capital outlay, to drive each large machine by a separate motor.

The electrical engineer who is to investigate such problems should carefully balance the cost of the existing system of driving against the interest, sinking fund, and maintenance of an electric drive. In some cases it will be found that the interest on capital outlay due to scrapping of old and purchase of new plant added to revenue charges will be so large as hardly to warrant a conversion, having regard to the interests of the shareholder, although there would be no question as to the proper course if starting *de novo*.

Coming to the net result with motor drives, it is remarked that not only is the loss in heavy main shafting obviated, but, since a well-designed motor is capable of a 50 per cent. overload for short periods, and over 100 per cent. for very short periods, motors of smaller rated powers are permissible for the several lineshafts than would be safe with steam or gas engines ; and the aggregate load, and therefore the power of the engine and boilers, may be much less than with the old system. These considerations help to explain how it is that much less boiler power is required to drive given works through dynamos and motors than with separate engines or engine driving through main and line shafting.

Two instances selected at random from Mr. Selby-Bigge's Düsseldorf paper will be instructive. At Messrs. Vickers Maxim's ship-building works at Barrow-in-Furness the average coal consumption per month during the winter of 1898, with steam-power, was 476 tons ; during the corresponding period of 1899, with electric power, the monthly consumption was only 232 tons, being a saving of about one-half.

Again, Messrs. Richardsons, Westgarth, and Company state that the output of their tools is now, with electric power, 30 per cent. in excess of what it was with steam. With the old shafts and belts the workmen were limited to say, two or three speeds as a rule, whereas with an electric drive their choice of speed was much greater. This is a point that is not generally appreciated, even by engineers.



[From "Modern Electric Practice."]

DYNAMO TEST PLATE (WESTINGHOUSE).

From 'Modern Electric Practice.']

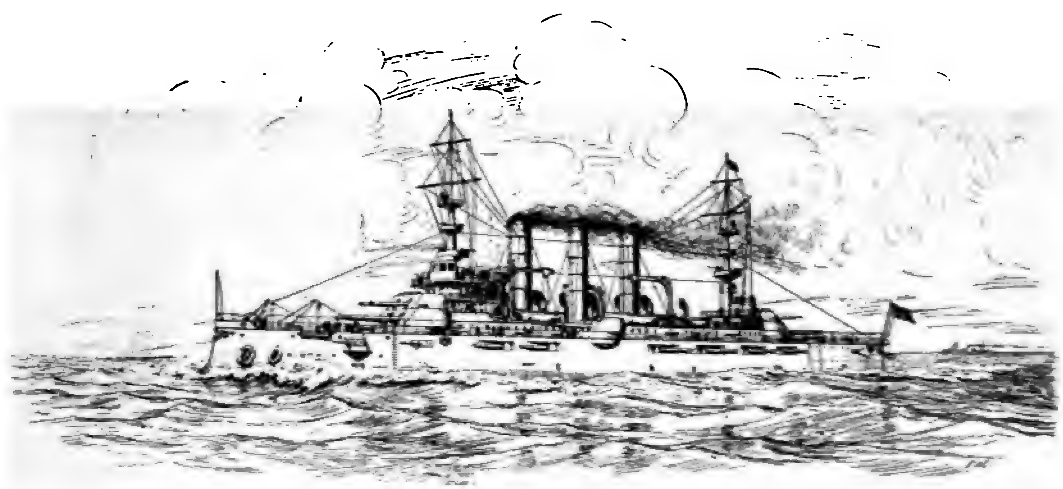
DIRECT-DRIVEN ELECTRICALLY OPERATED BORING MILLS.
At the British Thomson-Houston Company's Works, Rugby.

Of Polish descent, and born at Warsaw in 1867, Madame Sklodowska Curie studied at the University of Paris, where she obtained Master's Degree in Physics and Mathematics, and in due course married Monsieur Pierre Curie, Professor of Physics at the University. We next find her appointed in 1900 Professor of Physics to the State Normal School for Women at Sèvres. Taking up the subject of radio-activity as a thesis for her doctorate, and assisted by the Austrian Government, who placed at her disposal some tons of tailings of uranium ore, Madame Curie initiated the series of investigations which ultimately led to the discovery of radium, polonium, and actinium. Professor Pierre Curie soon joined the investigation, and in 1901 at Ivry, near Paris, was able to give practical effect to their discoveries by superintending the erection of refining works for the systematic treatment of the pitchblende refuse, which constitutes the raw material. Professor and Madame

MADAME SKLODOWSKA CURIE.

PROFESSOR PIERRE CURIE.

Curie, in spite of the homage paid to them by the scientific world, live comparatively secluded lives. They are essentially the type of people referred to by Mr. Andrew Carnegie, at the recent meeting of the Iron and Steel Institute. "I have just returned from Paris," said Mr. Carnegie, "and I met some of the men for which France is famous. Pasteur has passed away. I have been with Berthelot, your great scientist of world-wide fame. I have been with Monsieur Curie and his wife, the discoverers of radium. What a class of men—disdaining wealth, refusing patents for anything they have done, declining rank when it was in their power to attain it. They have led simple lives, dedicating themselves to the service of their fellow-men."



THE LATEST AMERICAN BATTLESHIP "VIRGINIA."

"P.M." MONTHLY ILLUSTRATED NOTES.

The U.S. Battleship *Virginia*.

The above sketch, for which we are indebted to the "Marine Review," shows the latest American battleship *Virginia* as she will look when completed. The *Virginia* was recently launched from the yard of the Newport News Ship and Engine Building Company, Newport News, Va. Her length on load water-line is 435 ft.; breadth (extreme) at load water-line, 76 ft. 2½ in.; trial displacement, about 14,948 tons; mean draught at trial displacement, about 23 ft. 9 in.; greatest draught, full load, about 26 ft. She will have a speed of at least 19 knots, her twin screws being driven by two four-cylinder triple expansion engines of about 19,000 i.h.p. The vessel will carry four 12-in. guns and eight 8-in. guns. She will have a broadside battery on the gun deck of twelve 6-in. rapid-fire guns, mounted six on each side, the secondary battery consisting of twelve 3-in. ·50-calibre rapid-fire guns, twelve 3-pounder semi-automatic, eight 1-pounder heavy automatic, two ·30-calibre machine guns, and six ·30-calibre Colt automatic guns. The *Virginia* will be provided with a complete waterline belt of armour 8 ft. in width amidships, 11 in. thick at the top and 8 in. at the bottom, tapering to a uniform thickness of 4 in. at the ends of the vessel. She will also have a casemate armoured belt, extending over about 245 ft. of her length, of a uniform thickness of 6 in.

Bolton's Downtake Superheater.

The advantages of superheated steam have long been recognised, but owing to the defects of design, and the want of suitable materials and packings and lubricants to withstand higher temperatures, its adoption has been retarded. These difficulties having been overcome, its application is being rapidly and successfully extended.

Theoretically, the higher the superheat the greater the economy; but practice has proved beyond doubt that the best all-round results are obtained with moderate superheat giving a final temperature of 500 to 560 deg. F.

The application of superheated steam will raise the efficiency of an engine to a higher grade, the equivalent saving averaging ten to fifteen per cent. of coal and twenty to thirty per cent. of water.

Of the accompanying illustrations one shows the application of Bolton's patent downtake superheater to a battery of eight boilers, and the other its position in the downtake flue at the back end of the boiler.

Briefly described, Bolton's downtake superheater consists of a top box comprising three chambers, inlet, outlet, and a passage from one to the other. The tubes are grouped in two equal sections through which the steam passes in succession, being dried and slightly superheated in the first section and raised to the required degree of superheat in the second.

The tubes are arranged on the "Field" principle, which ensures perfect circulation and the distribution of the steam in a thin film over the heating surface, which are most important points in a superheater. The steam enters the inlet chamber and passes down through the internal tubes of the first section, then up through the annular space into the top box, and down the annular space of the second section, and finally up through the internal tubes and into the outlet chamber which it enters in a superheated state.

The external tubes which are made by the "Mannesmann" process—are of mild steel, seamless and with the bottom end left closed in rolling. They are fitted tightly into the bottom of the box, then expanded and beaded over, forming a solid metal to metal connection.

The internal tubes are of "Loco" quality, and are securely fixed into the inlet and outlet chambers.

The top box is of Siemen's-Martin mild steel, 1 in. thick, dished and flanged by hydraulic force. The cover consists of a Siemens-Martin mild steel plate, 1⅛ in. thick, machined all over and having a solid strip along each of its long sides, which fits over the planed edges of the flange on top of box to relieve the joint, and bolts of side pressure, and it has suitable preparation for attachment of the steam pipes

BATTERY OF EIGHT LANCASHIRE BOILERS FITTED WITH BOLTON'S DOWNTAKE SUPERHEATERS, WITH DOUBLE CIRCULATION, IMPROVED BOX, AND "FIELD" TUBES.

to and from the superheater. It is also fitted with two lifting eyes and two thermometer pockets and a dead weight safety valve, and is secured to the box with forged steel bolts closely spaced.

The following special advantages are claimed for this form of superheater :—

(1) The design and arrangement of the box and internal chambers are reduced to the utmost simplicity, and are such as compels the steam to distribute itself over the whole of the tubes, instead of short circuiting through a few only.

(2) The requisite area is provided at all parts for the easy flow of the steam through the box and tubes, and all useless spaces and drop-in pressure are avoided.

(3) The body of the box and cover joint, and the greater portion of the cover, have never more than one temperature upon them at the same time, which ensures all equally expanding and contracting together throughout their mass, and thereby all risk of leaky joint and injury are entirely eliminated.

The tubes are free at their bottom ends to lengthen or shorten as the temperature of the surrounding gases rises or falls; this freedom ensures their straightness and prevents springing their top connection to the box.

It is further claimed that these superheaters can be readily applied, at a minimum cost, to existing plants, and with a substantial fuel economy varying from eight to fifteen per cent. For the above particulars of Bolton's Patent Superheater, with double circulation, improved box and "Field" tubes, we are indebted to the patentees and sole makers, Messrs. A. Bolton and Co., of 49, Deansgate, Manchester.

Messrs. Mather and Platt, Ltd., of Salford Iron Works, Manchester, have just received an order for two exactly similar sets of motor generators, and for a third pair of dynamos, all being for use in connection with the Johannesburg Electricity Works. Each motor generator set consists of a 250 kilowatt two-phase alternator for a current at 3,300 volts and a frequency of 50 cycles coupled to a pair of continuous current dynamos, each of 150 kilowatt capacity at pressures varying from 230 to 275 volts. In the first instance it is intended to drive each set direct from an Allen steam engine, provision being made for disconnecting the continuous current dynamos from the alternator if desired. At a later period the engine will be removed altogether, and then current from the tramway or lighting mains being supplied to the continuous current dynamos in series, these will act as motors, and drive the alternator attached to them ; or two-phase current being supplied to the alternator, the pair of continuous current dynamos driven by it will be used, either in series for supplying current to the tramways, or as balancers on the three-wire lighting system. The extra pair of continuous current dynamos will be precisely similar to those above described, and used as balancers on the three-wire system.

The Transandine Railway.

The accompanying map, for which we are indebted to the "Railway Age," shows the course of the proposed Transandine Railway. By the call of the Chilian Government for tenders to link up the existing lines every probability is assured that within five years or less a straight cross country trip can be made from Valparaiso to Buenos Ayres.

New Shallow-Draught Gunboat for the British Navy.

The use of the shallow-draught gunboat in warfare was recently demonstrated on the Yalu. Since we last went to press H.M.S. *Widgeon*, the latest twinscrew shallow-draught gunboat built by Messrs. Yarrow and Co., Ltd., of Poplar, for the British Navy, has successfully passed through her trials in the Estuary of the Thames. A six hours' run at 11 knots, and a two hours' run at 13 knots were made consecutively without a stop, the actual speeds being 11·030 knots and 13·058 knots respectively.

H.M.S. *Widgeon* is 160 ft. long and 24ft. 6 in. wide, the depth of hull being 6 ft. For facility of transport she has been constructed in sections. The machinery space is protected by chrome steel armour and an armoured battery 78 ft. long on the upper deck carries two 6-pounder quick-firing guns and four rifle calibre (·303) Maxim machine guns. There is also an armoured conning tower forward. The engines are of the compound condensing type, fitted with Yarrow boilers.

By the courtesy of Messrs. Yarrow and Co., Ltd., we illustrate this type of boat herewith. The *Teal*, *Moorhen*, and *Widgeon* are identical.

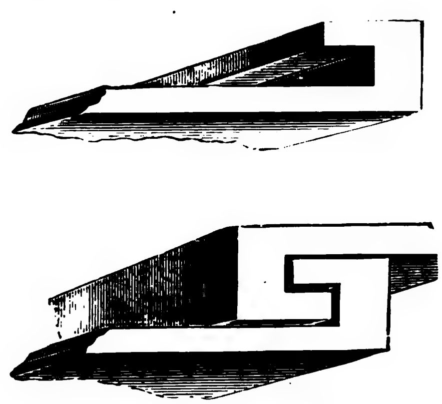
The Argentine Government have ordered a triple rock-cutter plant, for the removal of rock under water without explosives, from the patentees of this system, Messrs. Lobnitz and Co., Ltd., Renfrew, for service in the river Uruguay. Messieurs H. Hersent et Fils, the French contractors for rock excavation under water, have ordered a second patent rock cutter for their works at Dakar.

THE BRITISH SHALLOW-DRAUGHT GUNBOAT "TEAL."

A New Safe Construction.

The ingenuity of modern safe construction tends to make the burglar's calling one of increased difficulty and hazard. In the latest device which has been brought under our notice, he has something more difficult to encounter than a bolt shot out by mechanical means and secured in position by a lock.

Messrs. Phillips and Son, of Speedwell Works, Birmingham, are now making a safe in which the usual bolts round the inside of the door are replaced by a rolled steel channel section, the shape of which is indicated in the annexed diagram.



STEEL CHANNEL SECTIONS.

This steel channel runs on all four sides of the inside of the door, and by mechanical means somewhat similar to those used to shoot the bolts on other high-class safes, is *drawn inward* (instead of pushed outward) into a similar channel on the frame of the safe. This produces a result similar to hooking the fingers of one hand into those of the other. The two channels closing firmly together make it impossible for air, fire or water to penetrate to the interior of the safe.

PATENT CHANNEL BOLT SAFE.

The Midland Railway Company's New Steamer.

THE SS. "ANTRIM."

A detailed account was given in a recent issue of PAGE'S MAGAZINE of the Midland Railway Company's new Harbour at Heysham, in Morecambe Bay. The accompanying illustration shows the first of the new steamers to be run in connection with the Company's cross-channel service. This vessel—the *Antrim*—has been built by Messrs. John Brown and Co., Ltd. Its machinery, like that of the sister vessel which is being constructed by Messrs. Caird and Co., of Greenock, is of the ordinary reciprocating type, while the two further vessels, for which Messrs. Wm. Denny and Bros., of Dumbarton, and Messrs. Vickers, Sons, and Maxim, Ltd., of Barrow-in-Furness, are responsible, will be propelled by turbines. With a speed of 20 knots these fine steamers will be able to complete the passage in six hours, and as the train arrangements on this side of the channel will be expedited, passengers leaving town at five o'clock will arrive at Belfast in good time for breakfast next morning. It is also anticipated that a marked development in the Irish trade in dairy produce will ensue, and that the new service will help materially to develop the general prosperity of Northern Ireland.

Mr. Cecil E. Lugard, who has for several years been chief of the electrical department of Messrs. Ashmore, Benson, Pease and Co., Ltd., Stockton-on-Tees, has now entered into practice as a consulting electrical engineer at Field's-buildings, Middlesbrough.

The Birmingham Corporation have just placed an order with the British Westinghouse Electric and Manufacturing Company, Ltd., for a three-phase generating plant of an aggregate capacity of 3,000 kilowatts. This will consist of one 1,500 kilowatts rotating field 25 period, 5,000 volt generator, running at 166⅔ revolutions per minute, and three similar machines of 500 kilowatts each running at 250 revolutions per minute.

The Secretary of the Army Council, War Office, London, S.W., has placed a contract with Messrs. Geipel and Lange, Vulcan Works, St. Thomas-street, Southwark, S.E., for 51 Geipel's Steam Traps, this being the third repeat order, for the Royal Gunpowder Factory, Waltham Abbey. This makes a total of 147 Geipel Traps in use there.

From the "Syren."

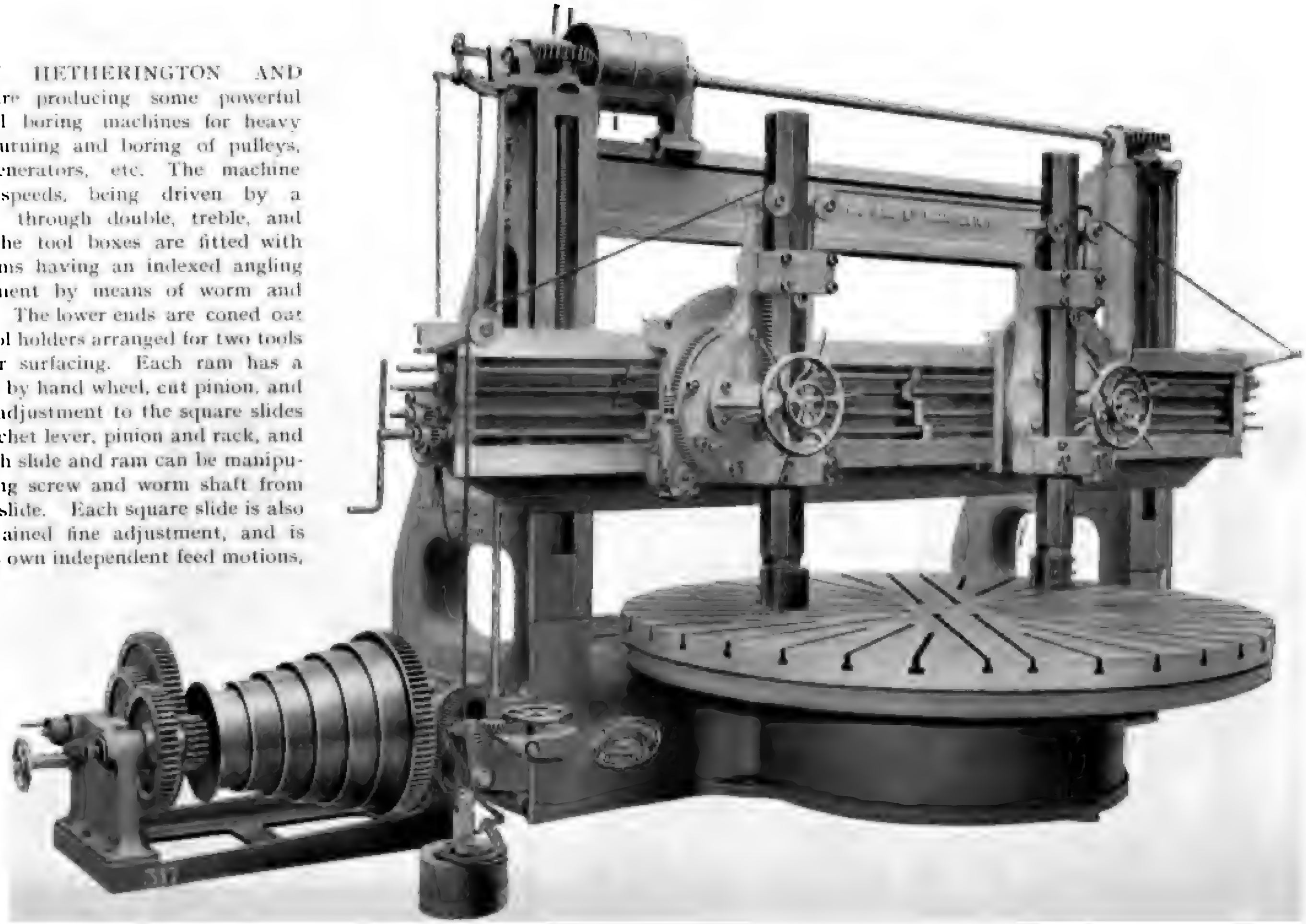
THE S.S. "ANTRIM.

THE BUILDINGS IN COURSE OF ERECTION FOR GLASGOW AND WEST OF SCOTLAND TECHNICAL COLLEGE.

The progress of the scheme is referred to in "Our Technical Colleges."

A HORIZONTAL TURNING AND BORING MACHINE FOR PULLEYS, FLY-WHEELS, ETC.

MESSRS. JOHN HETHERINGTON AND SONS Ltd., are producing some powerful horizontal turning and boring machines for heavy work, such as the turning and boring of pulleys, fly wheels, electric generators, etc. The machine illustrated has 36 speeds, being driven by a six-speed cone pulley, through double, treble, and quadruple gearing. The tool boxes are fitted with balanced octagonal rams having an indexed angling or swivelling arrangement by means of worm and worm wheel quadrant. The lower ends are coned out and fitted with steel tool holders arranged for two tools for boring, turning, or surfacing. Each ram has a quick hand adjustment by hand wheel, cut pinion, and rack, also quick hand adjustment to the square slides along cross slide by ratchet lever, pinion and rack, and for fine adjustment each slide and ram can be manipulated through traversing screw and worm shaft from either end of the cross slide. Each square slide is also fitted with a self-contained fine adjustment, and is fitted complete with its own independent feed motions, which are variable, continuous and positive, and can be instantaneously changed whilst the machine is in motion by means of the indexed hand wheel, giving a variation of eight feeds to each of the 36 speeds.



A POWERFUL HORIZONTAL TURNING AND BORING MACHINE. By Messrs. John Hetherington and Sons, Ltd., Manchester.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel Mining and Allied Industries.

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OUR MONTHLY SUMMARY.

LONDON, May 21st, 1904.

Printer's Engineering.

The services performed by the engineer for the modern printer were demonstrated in a marked manner at the recent International Printing Exhibition at the Agricultural Hall. Though there were few novelties, a most instructive collection of machinery was brought together, and perhaps the most significant feature of the exhibition was to be found in the exhibits of the various electrical firms who make it their business to cater for the printer. We have no space to discuss the reasons which render the electric motor an ideal appliance for driving printing machinery; its suitability for the purpose was freely demonstrated at the exhibition, the machinery being to a large extent motor driven. Machinery for the manufacture of many forms of stationary has now been brought to such perfection that it is not easy to see how further progress can be attained, but probably many of the public realised for the first time their obligation to the engineer for cheap envelopes, luggage labels, paper bags, etc. Printing machines in very great variety were to be seen at work, and another characteristic feature was offered by the exhibitors of process work and appliances, without which journalism as we know it could scarcely exist. Much interest also centred in the colour printing from aluminium plates on fast rotary machines, and in Messrs. Haddon and Company's model printing office. Particularly noticeable was the extraordinary insistence of the picture postcard, which literally papered the exhibition, including artistic pictures of considerable merit as well as veritable crudities.

A New Composing and Distributing Machine.

The practical printer, if asked to name the lion of the exhibition, would probably begin to talk about the new composing and distributing machine for loose type exhibited for the first time by the Pulsometer Company, Ltd. The stand was crowded at the time of our visit. An operator was "typing" off a report in brevier, and another, at the distributing machine, was as busily engaged in "dissing" it. We thought of our old friend the "case," and wondered how long it will be ere inventors devise a satisfactory scheme for printing *without type*. It is claimed for the machine that it is simpler, cheaper to build, of greater speed and lighter touch than any loose type machine hitherto invented. It will take any founder's type, and will set three bodies, *e.g.*, minion, brevier, and bourgeois, without alteration. The distributing machine, which, we gathered, is to be further perfected, is also constructed to take the un-nicked type of any founder, and of any "body" by a change of sieve. The types are assembled in the composing channel of the type-setting machine by passing down a grooved front plate or apron, but the troughs containing the types are placed horizontally instead of vertically, and are permanently fixed, the feeding being accomplished by a special device. The troughs are arranged in a series of steps, symmetrically on each side of the centre of the front plate. There

are eight of these steps, six containing fourteen troughs each, and two containing sixteen each, making one hundred and sixteen troughs in all, which allows for upper and lower case, small caps, figures, and the usual sorts.

Each depression of a key acts upon a lever liberating the corresponding letter, which falls down automatically into place. The type then passes to the left of the machine, where it is automatically divided into lines, the adjustment being done by hand. Power from a small motor is imparted by a clever arrangement of oscillating plates beneath the levers, thus reducing the "touch" required for manipulation to less than two ounces. The distributing machine is no less ingenious, and has been designed to work at a speed which will give its operator ample time to keep the composing machine fully supplied. It is claimed that the latter produces a line of printing type at a greater speed than it can be typewritten from MS.

Bradford Exhibition.

Another exhibition opened last month was that inaugurated at Bradford by the Prince and Princess of Wales in connection with the completion of the Cartwright Memorial. It will remain open until October to stimulate the manufacturing industries of Bradford, and prove the superiority of English-made goods. This building has been erected at a cost of about £70,000 to perpetuate the memory of Dr. Edmund Cartwright, the inventor of the power loom, and it has been given by Lord Masham, the inventor of a later wool-combing machine, and of many other appliances, used in connection with local industries. It is a compact structure, covering about 60,000 square feet.

The machinery section, though not so large as might have been expected, recalls in a striking manner the history of the inventions which have made Bradford industries what they are, and the evolution of the loom at the hands of such men as Lister, Donisthorpe, Noble, and Cartwright. Textile machinery is exhibited by Messrs. James Holdsworth and Co., of Halifax, George Hodgson, Ltd., of Bradford; George Hattersley and Sons, Ltd., of Keighley; D. Sowden and Co., of Shipley; J. Pilling and Sons, of Colne, and others, and Messrs. Matthews and Yates have a comprehensive exhibit, in which prominence is given to the Cyclone Air Propeller. One of the most interesting stands is that of the Bradford Technical College, which, more particularly in the systematic study of dyeing and colour processes, is doing such admirable work for the industries of the town and district.

The Thames Barrage.

A correspondent writes :—

If the dam were built across the Thames at Gravesend, where would the sewers be emptied? At present, I believe, the main London sewer is emptied near Barking! Would it not cost an enormous sum to carry the sewer below the proposed dam?

Mr. T. W. Barber, M.Inst.C.E., who is responsible for the scheme, replies as follows :—

The London sewage is treated by chemical precipitation at Barking and Crossness, and only the effluent is run into the river. It has always been considered desirable to carry these outfalls down to the estuary below Gravesend, but the cost (estimated at £4,000,000) and the probability that bacterial treatment may be eventually adopted—which would avoid the necessity of such removal—have delayed the carrying out of the proposal; besides which the improved condition of the Thames of late years, which has been so marked, has diverted public attention from the subject.

But the construction of the barrage will not make these conditions worse than at present, but better, by removing the zone of greatest pollution about fifteen miles down the river, instead of in front of London, as it now is. No part of the river will then be worse than it now is, but the lower river—instead of becoming more foul, as many have supposed—will be in better condition, owing to the river being always full and free from admixture of salt water, while the natural bacterial purification which goes on in fresh water rivers will be more effective than it now is. It is generally acknowledged that only the upland fresh water is effective in keeping the river clean, and there will be the same upland flow then as now.

In view of the interest aroused in the objections urged before the Thames Conservancy Board by Sir John McDougall and others, the following objections, with Mr. Barber's replies, are also appended :—

Objections and Replies.

Admiral Bosanquet thought the figures of cost were likely to be quadrupled, that is, sixteen millions, instead of four.

This opinion, says Mr. Barber, is not based on any expert evidence. It is, of course, impossible to say what sum would be spent in compensations, Parliamentary and legal expenses, but the cost of works proposed is a matter of engineers' estimate based on plans and current prices, and there is no reason to suppose that the sum named need be exceeded. But even if the barrage costs a great deal more than four millions, it will be an exceedingly cheap solution of the problem of the port.

The Storm Water Question.

Sir John McDougall said also: *"It will be impossible to deal with the storm water of London."*

This, certainly, is not impossible, writes Mr. Barber. It is a question of a suitable scheme and of means. It may be said at once that it is impossible to conceive of any conditions of drainage that cannot be effectually dealt with by the engineer.

The London main drainage was never intended to carry off storm water in excess of a moderate mean. Hence the main sewers will not carry off heavy storm waters, and a number of overflows have been left into the Thames mostly below the level of high water. The main drainage has, therefore, never been completed, and it has always been the intention to supplement these with pumping stations, by which they can be kept discharging even at high water. Several such stations have been provided, and others are contemplated. (See reports of Main Drainage Committee.) Under existing arrangements flooding does now occur in low-lying parts of London whenever a heavy rainfall accompanies a high tide, which cannot be said to be a satisfactory condition of things.

A system of dealing with these could be readily devised, and would have to be provided.

The best method would be by underground reservoirs and pumping stations at suitable places. But it might be difficult to find sites for the reservoirs, though they could consist of large intercepting sewers running chiefly under main streets, and might be combined with shallow subways, such as are now proposed for parts of London. The simplest method is the provision of a pumping station at or near each important

overflow, the smaller ones to be led to these stations. The quantity of storm water that will need pumping is only 4 per cent. or 5 per cent. of the total London sewage, or, say, an average of 10,000,000 gallons per day, about one-tenth the quantity dealt with daily at Abbey Mills; but this water falls at uncertain intervals, and the overflows have been found to discharge into the Thames on about 12½ days per annum on the average, the time of flow varying from a few minutes to several hours. Much larger quantities, therefore, may have to be pumped in a few hours. The existing storm water pumping stations have been found to need working only from 73½ to 321 hours per annum. Gas or oil engines of high power are, therefore, very suitable for this work, and the cost of such a scheme must, of course, be added to that of the barrage, and will permanently avoid flooding in London.

The Essex and Kent low-lying lands drainage must of necessity also be pumped into the river, which will greatly improve these lands, as they are now frequently flooded, owing to the intermittent and inefficient drainage, which can only now be discharged at low water, but the cost of all those pumping outfits will not be a large one when it is considered that flooding from tides and storm water will be permanently put an end to.

Further Objections by Admiral Bosanquet.

Admiral Bosanquet also said: "*There will be great delay to the shipping at the locks of the barrage.*"

This, says Mr. Barber, very emphatically, is an error. These locks will be at work twenty-four hours per day. A great many vessels will be passed through with all the gates open at high water. There will be no fleets of vessels arriving at particular states of the tide, but may be expected to arrive at all hours of the day and night, especially as to outbound vessels; the river, the docks and wharves being equally free for navigation at all hours of the day. Every modern appliance for rapidly handling the traffic in and out of the locks will be provided.

Another objection put forward by Admiral Bosanquet was that "*the construction of the barrage will so impede the traffic while it is in progress that the shipping will be driven away from the port of London.*"

There is no ground for this supposition. At all times during its construction the greater part of the waterway will be open to traffic. The barrage will be built in sections. The locks in the centre of the river, when finished, can be thrown open, and provision thus made of four or more 100 ft. passages for vessels with guiding booms and fenders open at all states of tide. The obstruction will cause no delay of importance, as, of course, a system of marshalling the traffic with provision of guiding booms, fenders, and other appliances will be adopted.

The Art of Packing Machinery.

Some very valuable suggestions for packing of machinery intended for foreign shipment were presented by Mr. Paul Roux in the course of a paper read before the American Chamber of Commerce, at Paris. The advantage is pointed out of dismounting a machine weighing over two tons in order to pack it in several packages, each weighing less than this maximum. Care must be taken, however, that the total tonnage or cubage of the several packages does not exceed that of a single case, and that the difficulties of assembling the machine at destination do not more than counterbalance the economy realised on transportation charges. It is also profitable to dismount a machine weighing either more or less than two tons when this secures a considerable reduction in volume, and when, as is generally the case with machine-tools, the cubage exceeds the limit of 40 cubic feet per ton.

All delicate or fragile parts which cannot be removed should be carefully protected against rough handling during unpacking. All screw threads should be carefully covered with wood or rags; all tapped holes, oil holes, and, in general, all openings through which dirt can reach the interior of the machine, should be carefully closed with wooden plugs. Manufacturers are especially urged to tag all pieces which may have been removed with labels fully explaining their position on the machine.

When a machine-tool has been properly dismounted and divided for packing, the very important operation of protecting the finished parts against rust must be carried out. The coating applied should be sufficiently fluid at the time of its application to permit of its reaching all parts of the surfaces to be covered. It should be free from all trace of acid, and should dry rapidly. Moreover, it should be readily dissolved with oil, petroleum, or turpentine when the machine has reached its destination and is ready to be set up.

Packing Cases for Abroad.

Two conditions are laid down for packing cases intended for abroad. They must effectually protect the machine against all shocks and injury during transportation, and must facilitate the handling of the machine. The bottom of the case should be sufficiently strong to carry the total weight of the machine without the assistance of any other part when balanced on a roller. It should be constructed with two longitudinal battens, in order that the case may be moved on rollers when cranes are not available, and these battens should be bevelled at the ends to facilitate their employment. Transverse planking, spiked to the battens, forms the bottom of the case. On the bottom, constructed as indicated, two frames should be built around the machine, dividing the length of the case in three parts, in such manner as to support the pressure of ropes or chains when handling with cranes or other hoisting apparatus. These frames will, at the same time, act as supports for the interior braces, and as lateral supports in case the package is laid on its side, which often happens in spite of instructions. Around these principal elements are built the sides, ends, and top of the case, which are designed simply for protecting the machine generally.

In designing the packing-case, it is very necessary to make provision for the examination of the machine in the Custom House, and even for removing it completely. It is absolutely necessary in all events to arrange an opening in one of the sides or in the cover, through which the nature of the machine may readily be seen. Manufacturers are recommended to avoid lining the cases with paper, and to fold all drawing lists, cuts, etc., in waterproof paper, which should be tacked inside the case near the inspection opening. With regard to exterior marks, attention is called to the necessity of marking the absolutely exact net weight, as even a very small difference between the weight stated and the true weight may cause difficulties in the Custom House; and, perhaps, the imposition of fines. Exporters are also recommended to paint a black circle around the heads of all nails and screws which should be removed, in order to unpack the machine with the least work and without injuring the panels and bracings.

NAVAL NOTES.

MONTHLY NOTES ON NAVAL PROGRESS IN CONSTRUCTION AND ARMAMENT

By N. I. D.

GREAT BRITAIN.

THE annual Parliamentary return showing the fleets of the seven most important Naval Powers makes, as usual, very instructive reading. It distinguishes the vessels built and building, and gives the date of launch, displacement, and armaments, and is corrected to March 31st last. Vessels, according to the explanatory notes which accompany the return, are not transferred to the "built" from the "building" lists until they are actually ready for commissioning. Moreover, vessels in the official fighting strength of a navy are still included in the return, except in such cases where there is information to prove that vessels officially described as "effective" are assigned to special and non-seagoing duties. The tabulated statement which accompanies the return showing the strength of the various fleets in the built and building classes respectively, is given below:—

BUILT.

	G. Britain.	France.	Russia.	Germany.	Italy.	U. States.	Japan.
Battleships, 1st class ..	49	20	16	14	13	11	6
" 2nd class ..	4	9	4	4	—	1	1
" 3rd class ..	2	1	1	12	3	—	—
Coast Defence Vessels, Armd.	1	14	14	11	—	11	2
Cruisers, Armoured ..	28	15	8	4	5	2	8
Cruisers, Protected:							
1st class	21	7	5	1	—	3	—
2nd class..	*49	16	*3	8	5	15	12
3rd class	*32	17	2	13	†13	2	8
Cruisers, Unprotected ..	8	1	3	20	1	7	9
Torpedo Vessels	32	‡16	9	2	14	—	1
Torpedo-boat Destroyers ..	124	24	47	37	11	20	19
Torpedo boats	87	233	167	86	138	31	82
Submarines	8	26	1	§ 1	1	8	—
	445	390	280	213	204	111	148

BUILDING.

	G. Britain.	France.	Russia.	Germany.	Italy.	U. States.	Japan.
Battleships, 1st class ..	10	6	9	6	5	11	2
To be laid down 1904-5 ..	2	—	—	2	1	2	—
Cruisers, Armoured ..	13	6	—	2	1	11	—
To be laid down 1904-5 ..	4	3	—	1	—	—	—
Cruisers, Protected:							
1st class	—	—	3	—	—	—	—
2nd class..	2	—	—	—	—	2	1
3rd class	4	—	2	4	—	—	—
To be laid down 1904-5 ..	—	—	—	3	—	—	—
Scouts	8	—	—	—	—	—	—
Torpedo-boat Destroyers ..	22	9	14	—	2	—	1
To be laid down 1904-5 ..	14	6	—	6	—	—	—
Torpedo Boats	4	20	—	—	8	1	3
To be laid down 1904-5 ..	—	74	—	—	6	—	—
Submarines	11	14	‖14	—	3	—	—
To be laid down 1904-5 ..	10	34	—	—	2	—	—
	104	172	42	24	28	27	7

* Including one partially protected.
† Including two partially protected.
‡ Including one torpedo depôt ship.
§ Experimental.
‖ Not certain whether all these have been actually commenced.

A few unofficial particulars about the new battleships of the *Lord Nelson* class, provided for in this year's Estimates, have appeared, and, according to these, the vessels are to be of only 15,000 tons displacement. The plan of building 18,000 ton battleships appears, indeed, to be shelved indefinitely for a variety of reasons. The speed of the *Lord Nelson's* is to be about 18 knots, and for armament they are to carry four 12-in., eight 9·2-in., and twenty 12-pounders. According to another authority the secondary armament is to consist of fourteen 7·5-in. pieces, it being definitely stated that no guns of 9·2 in. calibre will be carried.

Particulars of the steam trials of the *Cornwall* to hand show that she is fully up to the standard set by other ships of this class in point of speed and coal consumption. Her boilers are of the Babcock and Wilcox type, twenty-four in number, with a total heating surface of 56,604 square feet. At the thirty hours' one-fifth power trial the total horse-power indicated was 4,800 (300 in excess of contract), and the speed attained 15·3 knots, on a coal consumption of 1·73 lb. per unit of power per hour. At the thirty hours' four-fifths power trial the horse-power was 16,487, the mean speed 21·83 knots, and the coal consumption 1·69 lb. per i.h.p. per hour. On her full power trial of eight hours' duration the following were the results: Steam pressure in boilers, 242; revolutions, starboard, 148·7; port, 147·2; total indicated horse-power, 22,699 (699 in excess of contract); mean speed, 23·689 knots; coal consumption, 1·94 lb. per unit of power per hour. These are the results as officially reported, but the horse-power at one time was nearer 24,000 than 23,000, with a speed proportionately nearer to 24 knots, and when it is remembered what difficulty was experienced in making the first vessels of the class attain even 22 knots, it is obvious that the modifications which have been introduced into the propellers must have been necessary for the efficiency of the ships.

The trials of the *Widgeon*, shallow draught gunboat, have been carried out by Messrs. Thornycroft, and have resulted in the vessel attaining the (for a vessel of her class) remarkable speed of 13 knots. This is brought about by a patent device invented by the builders, the result being nearly a knot increase in speed.

The torpedo-boat destroyers *Exe*, *Ettrick*, and *Erne* have been completed and commissioned, and have gone to the Mediterranean station. In addition to the thirteen other vessels of last year's programme, particulars of the building of which have already appeared, it is to be noted that two others, making the total of fifteen allowed for in the Estimates, are building by Messrs. J. S. White and Sons, Cowes. They are to be known as the *Ness* and the *Nith*.

It has been decided to establish a permanent submarine depôt at Portsmouth, and to make this the headquarters of the school of underwater craft. While I do not for one moment advocate leaving Portsmouth entirely without a submarine flotilla, I would certainly suggest that Portland is a more suitable headquarters for the submarine school than Portsmouth can ever be.

FRANCE.

The event of the past month has, of course, been the launching of the battleship *Democratie* at Brest on April 30th. Three battleships off the stocks in seven

months is the record of French naval progress since the *Republique* took the water at this same port in September last. The *Democratie* is one of the 1900 programme vessels, displacing 14,927 tons, and with engines of 17,500 h.p., developing 18 knots speed. Steam is to be supplied by Belleville boilers, although it is reported that another type may be introduced. The keel was laid on May 1st, 1903, making one year to a day to the launch. The *Democratie* is expected to be placed in commission early in 1907. Her length is 442·9 ft.; beam, 79·5 ft.; draught, 27·5 ft. The thickness of the armour belt is 11 in. amidships. For principal armament she carries four 12-in. guns, two in each turret fore and aft, and her secondary battery is composed of ten 7·6-in. guns, six mounted in turrets and four in casemates below them. There are also twenty-six 1·85-in. guns. The complement will consist of 30 officers and 760 men. The protection of the ship follows a new method. The general use of large and quick explosive projectiles has led to considerable modifications in the mode of protection of French fleet battleships. The new vessels of 15,000 tons, similar to the ship just launched, will have all their above-water parts protected by an interior shell, armoured on all sides and furnished with multiple sub-divisions. The thickness of the outer protecting belt has thus been reduced without inconvenience in view of the probable smaller area affected by a penetrating shell. At the same time, the height of the belt has been somewhat increased in order to protect the lower portion of the above-water construction. Armoured bridges and sheltered bridges (protection from flying splinters) complete the armour protection. It is confidently stated that the battleship will not be sunk from the effects of the explosion of any one torpedo.

A correspondent of the "Engineer," writing on the subject of the armament of these four vessels, the *Democratie*, *Liberté*, *Justice*, *Vérité*, gives some very interesting particulars about their armament. Their 7·6-in. guns, for instance, throw a projectile of 189·7 lb. (86 kilos), which is nearer the 200 lb. of the British 7·5-in. than was formerly believed to be the case. Then, again, no decision appears to have been made as to the inclusion of eight 4-in. quick firers in the secondary battery. The 1902 gun also has an initial velocity of 3,002 ft., is slightly heavier than the 1893-96 pattern, and about five calibres longer. These guns are to form the primary battery in the armoured cruisers *Jules Michelet* and *Ernest Renan*.

The *Jeanne d'Arc*, armoured cruiser, although she has now been in commission some months, has never yet succeeded in making her contract speed of 23 knots, in spite of continual alterations and improvements. On her last attempt she could not do more than 21·78 knots, although her engines were developing 33,000 h.p. The *Gloire* has now completed her trials, and will shortly be commissioned, but the *Condé* has still to make her official full speed trial.

There have been very unfavourable reports about the speed of the armoured cruiser *Dupleix*, which has recently joined the French Mediterranean squadron, and she is to go into dock for modifications to her propellers. She seems, however, to be capable of very good steaming, and made a good run from Las Palmas to Cherbourg at the end of April.

In small craft there is very little progress to report. The *Sabre*, torpedo-boat destroyer, the last of the *Pertuisane* class, has been launched, and the torpedo-boat destroyer *Francisque* has made 30 knots on a full speed trial. In submarines there is only the launch of the *Otarie*, of the *Naiad* class, to note. A new submarine *X*, designed by M. Romazotti, Chief Engineer in the French Navy, has just been completed, ready for service. She is one of a series of experimental boats decided on in 1901, and commenced in the following year. She displaces 168 tons, is 121·39 ft. long, and has a speed of 10·5 knots. The motive power is supplied by a current from the accumulators, or by engines worked by vapour explosion. Two other boats, *Z*, built at Rochefort from the designs of Chief Engineer Maugas, and *Y*, built at Toulon from the designs of M. Bertin, are complete.

GERMANY.

It is announced that the new battleship "M," building at the Schichau Yards, Danzig, will be launched, in the presence of the Emperor, on May 27th. As already reported, she is to be named *Lothringen* (Lorraine), and is, of course, a sister ship to the *Elsass* (Alsace) and *Braunschweig*, being the last of the class to take the water. Countess Zeppelin, wife of the President of Lorraine, will christen the ship.

A new armoured cruiser, the *York*, has taken the water at Hamburg. This vessel has hitherto been known as the *Ersatz Deutschland*. Countess York of Wurtenberg presided at the launching ceremony.

Another small cruiser, the *Muenchen*, has been launched at the Weser Company's yard, Bremen, on April 30th. The *Muenchen* is a sister ship to the *Hamburg*, *Berlin*, and other small protected cruisers named after German towns. She was christened by Prince Ludwig of Bavaria, in the presence of the Chief Burgomaster of Munich.

The series of torpedo boats *S* 120–125 being nearly complete, arrangements are in hand for the commencement of a further series *S* 126–130. When the former series is complete the German Navy will possess thirty-six fast modern torpedo boats, and eighty second-class slower vessels.

UNITED STATES.

The *Rhode Island* battleship, was not off the slips quite so soon as was anticipated. And the launching ceremony, which took place on May 17th, was attended by an accident, which, while it fortunately did not have any fatal results, might easily have caused a catastrophe. The anchors failed to hold the vessel after she had got into the water, and she was driven on to a mud bank opposite. The tide was falling at the time, and it was impossible to refloat her that day, but she was subsequently got off, and the bottom being soft, suffered little damage.

The armoured cruiser *California* was launched at San Francisco on April 28th. She will have a displacement of 13,800 tons, and an indicated horse-power of 23,000, giving a speed of 22 knots. Her principal dimensions are: Length, 502 ft.; beam, 70 ft., draught, 24 ft. 6 in. At the maximum draught of 26 ft. 6 in. the top of the main belt will be 12 in. above water. Her armament will consist of four 8-in. guns in pairs in the turrets, fourteen 6-in. quick-firers, eighteen 14-pounders, twelve 3-pounder semi-automatic, four 1-pounder quick-firer, four 1-pounder automatic, two ·30 Gatling, six ·30 Colt, and two 3-in. field guns. She will also carry two torpedo tubes submerged forward. She has a complete steel belt, 7½ ft. wide, for 244 ft. amidships, 6 in. thick at the top and 5 in. at the bottom. On the bow and stern it is 3½ in. thick, and above the belt to the upper deck for 232 ft. it is 5 in. The barbettes and turrets are protected by armour 6 in. thick, with 6½ in. at the

port plates, and the conning tower has 9 in. and the signal tower 5 in. armour.

The new protected cruiser *Denver* has been accepted by the Navy Department, although she failed to attain her contract speed after repeated trials. The best she could do was 16·7 knots, which is 0·3 below contract. She was built by the Neafie and Levy Co., of Philadelphia.

MINOR NAVIES.

AUSTRIA.—Considerable progress has been made in Austrian warship-building recently. A new monitor, the *Bodrog*, was launched at Budapest on April 12th, and a sister vessel, the *Temes*, took the water a few weeks previously. These vessels are 183·73 ft. in length, with a beam of 30·84 ft., and a draught of 3·93 ft. They displace 440 tons, and with engines developing 1,400 h.p., are designed for 11 knots. The armament consists of two 6·7-in. quick-firers, one 4·7-in. howitzer, and three mitrailleuses.

The new battleship *Erzherzog Friedrich* was launched at Trieste on April 30th, and was christened by Archduchess Isabella, wife of the present Archduke Fredrich. The *Erzherzog Friedrich* displaces 10,600 tons, and is built for 19½ knots. Another vessel, the *Erzherzog Karl*, is already launched, and when the third vessel of the class is launched in about two years' time, the Austro-Hungarian Navy will have nine modern battleships, making three homogeneous squadrons. This is thought sufficient for the purposes of coast defence, and efforts will then be made to replace the obsolete torpedo craft of the navy by modern vessels.

The Austrian Navy Budget for 1904 totals £2,100,000, of which £1,656,000 is deemed ordinary expenditure, and £444,000 extraordinary. The items are divided, as follows:—

The allowance for new construction is £946,000; £159,600 on account of the armoured cruiser *Saint Georg*, of 7,360 tons; £243,600 on account of the battleship *Erzherzog Karl*, of 10,600 tons; £201,000 on account of the sister ship *Erzherzog Friedrich*; £92,400 on account of "C," a third battleship of the same type; £157,200 on account of the coast defence ship *Babenberg*; and £24,000 only for the completion of the sister ship *Arpad*. The Budget shows an increase of £44,000 only on that of the previous year.

JAPAN.—The names of the two battleships of which I gave a description in last month's notes are to be *Kashima* and *Katori*.

TURKEY.—The new Turkish cruiser *Abdul Hamid* has completed her speed and gunnery trials, and has left for Constantinople. A mean speed of 22·25 knots was obtained on six runs over the measured mile, and on a six hours' natural draught trial she did 21·1 knots. The machinery worked without any trouble, and the gun trials were considered satisfactory. The *Abdul Medjidi* has been delivered from America. The Turkish Government is reported to be so well satisfied with this vessel that several more are to be ordered from American firms.

MEXICO.—The new gunboat *Tampico* has completed some satisfactory trials, making a speed of 15·90 knots under forced draught. A sister ship, the *Vera Cruz*, attained a speed of 16·25 knots. She is building by the Crescent Company, Elizabethport.

RUSSIA.

So far as naval interest is concerned, the war in the Far East is for the moment in a state of suspended animation. Admiral Togo has succeeded in blocking the harbour entrance at Port Arthur in so far as the passage of battleships and armoured cruisers is concerned. It cannot for one moment be doubted that the Japanese fully understood the necessity for rendering the Port Arthur fleet ineffective as a preliminary to successful land operations. This explains in some measure Admiral Togo's repeated attacks on the port. Finding that he could not get the Russian fleet out in the open to destroy it, he decided to bottle it up. What Admiral Skrydloff will do remains to be seen. He will, of course, take over command of the Vladivostok squadron from Admiral Jessen, but whether he will be able to effect anything with it is doubtful. It is hopelessly inferior to the fleet under Togo, who is now reported to have established himself in Possiett and Ussuri Bays, and to have mined the entrance to Vladivostok. The only result of a sortie by either Jessen or Skrydloff at the present juncture would be wholesale destruction, and since the Port Arthur fleet is hopelessly ineffective, the question of reinforcements from Europe may be looked upon as settled.

The forcing of the passage of the Yalu by Baron Kuroki was, if subsequent reports are to be believed, unlooked for by the Russians. General Sassulitch, and possibly Kuropatkin also, studiously undervalued the energy and initiative of Kuroki, and the consequence was defeat. Kuropatkin is believed by the Russians to be the finest strategist they have had for several generations. But a strategist whose plans involve the defeat and destruction of an army corps, and imminent annihilation for himself and his main army, needs some explanation. At the moment of writing Kuroki is closing round Kuropatkin on all sides. The Second and Third Japanese Army Corps have landed on the Liao-tung Peninsula, and with his own victorious First Army Corps Kuroki is hastening to the north-east to cut the Russian communications with Harbin. Kuropatkin, it would seem, has totally failed to realise the necessity for a less extended front and a shorter line of communications. The time is getting short, and before these lines can even appear it seems likely that a second and more decisive battle than that at Kin-leng-Cheng will have been fought. Kuroki is working to once more outflank his opponent, and if he does that, I can see nothing but ignominious surrender for the greatest Russian strategist of several generations.

ELECTRICAL AFFAIRS.

BY

E. KILBURN SCOTT, M.I.E.E., A.M.Inst.C.E.

Dust Round Electric Conductors and Fittings.

Although one of the claims put forward in connection with electric lighting as against gas and oil is that it is much cleaner, still, at the same time, it has been noticed that there is a tendency for dust to accumulate on and about electric light fittings and wires, etc. Of course, the amount of dust so collected is only small, and it is mainly of interest as an electrical phenomenon. One explanation for the dust particles being deposited near such electrical conductors is that it is due to local heating. Another is that the dust particles being at air potential are attracted to the electrical conductor which is above air potential, and they either stick to this permanently, or becoming charged they are repelled and stick to the adjacent walls.

It has been noticed that the collection of dust has become more marked with the increased use of the 200-volt system. One way to reduce the trouble is to place the switches on the non-earthed or *positive side* of the circuit, so that the deposition of dust can then only occur during the time the lamps are alight. Mr. D. S. Munroe has pointed out that a still further improvement can be effected by the use of concentric flexible conductors instead of the ordinary twisted cord, the outer conductor being connected to the earthed side of the system.

The Future of Small Electrical Firms.

The present severe competition makes it doubtful whether some of the smaller firms will be able to carry on. It will certainly be a thousand pities if they do go under, for anyone who has had experience in both a small and a large establishment knows that as a training ground the former is far and away the best. Most engineers of to-day learnt their business in a small works, and if one inquires into the careers of the leading men in large establishments, it will more often than not be found that they have been promoted as a result of self-reliance and all-round qualities learnt in small works. The all-round training is especially valuable for colonial life.

A small works calls for individuality in the managers and the owners, and as England has been built up by *individual effort*, any movement which tends to reduce this, needs to be kept in check. In the writer's opinion it is better, in any particular community, to have ten small firms than one very large one, in much the same way that it is better to have ten different trades in a town than to have one. Bradford, for example, is handicapped as compared with, say, Leeds, by being practically dependent on one industry. It is a moral certainty that if the men who are now running small industries become merely the employees of a few large concerns, then future generations will lose in independence of character and thought, and also probably in inventive and *executive* ability.

The Coming of the Electrical Trusts.

Large concerns are, unfortunately, not the end of the trouble, for abroad, concerns which in themselves are large, are joining together to form large Electrical Trusts, with the single idea of creating monopolies. In America a new feudalism is growing up, which, behind an appearance of democracy, is simply the irresponsible domination of a few money magnates. With us it has always been a maxim that an employee can do what he likes in his own time, but in the States there is an elaborate system of espionage in the works and office, and confidential reports are sent in periodically to the management. We have a wiser system of laws protecting the worker against the unfair employer, but it behoves us to see that trusts do not get a foothold in this country, and to this end all *small independent firms* should be encouraged.

With such encouragement there is reason to believe that many of the smaller firms will be able to tide over the present period of over-production, and under normal conditions the writer believes they will more than hold their own. After all, the bedrock price of any article is the price at which it can be made by a private concern, which has no white elephant to provide for, in the way of over-capitalisation, or in large sums paid away for patent rights, etc.

Cosmopolitan Personnel.

In both American and Continental electrical works the cosmopolitan character of the personnel is very marked.

In the case of the technical staff the free interchange of ideas which has resulted has undoubtedly been of great advantage, and led to the development of an *international type* of engineer, of which Mr. Brown of Switzerland, and Mr. Steinmetz, of the States, may be taken as typical examples.

In the case of continental workmen, also, the advantages are considerable. It will be easily seen that it is a comparatively simple matter for a man to journey from one works to another by simply crossing a frontier line, whereas in this country it is quite a different proposition. The English Channel has its advantages, but it does undoubtedly help to narrowness of ideas; the ordinary mechanic, for example, cannot tramp from England into, say, Belgium, France, or Switzerland, as he can from place to place in England.

The cosmopolitan character of foreign workshops is distinctly one to the good, as it teaches men of each nationality that they are not the only melons on the patch.

More Technical Management

Some engineering concerns in this country are run too much from the commercial side. One result of this is that, while the accountants and clerking departments are well staffed and looked after, the drawing office and technical side generally is made to feel that it is barely tolerated. Figure-head directors give secretaries and accountants too much power, and when these latter get a smattering of technical knowledge, as they must do by constantly reading letters, etc., they are, like most people with a little knowledge, dangerous both to themselves and those associated with them.

In a foreign works the management and running of the business is centred in and around the drawing office, which has distinctly greater powers and responsibility than its English equivalent. The result is that, taking them all round, the personnel of the foreign drawing office is higher than in this country. It stands to reason that good men will not stay in a position where they are likely to be ordered about by promoted clerks, and other varieties of the pen-pushing class.

POWER STATION NOTES.

By E. K. S.

Load and Diversity Factors of an Electric Power Station.

The term "load factor" in connection with power stations is a term which denotes the ratio between the *actual output*, and the output if the station was to always work at uniform maximum power. For example, a station which sometimes has to supply 20,000 kilowatts, but whose average supply is only 10,000 kilowatts for twelve hours a day, is said to have a 25 per cent. load factor. Clearly, a station with a 100 per cent. load factor would earn a maximum revenue all the year round, and other things being equal, the 25 per cent. load factor should give one-quarter the revenue. Interest on capital is one of the principal items in the cost of producing electric energy, and this of course remains constant whether the load factor is 100 or only 25 per cent. In order to get a good load factor it is necessary to have what is called a good "diversity factor." That is to say, in the case of a Power Company supplying all kinds of customers, the area covered should include as great a diversity of demand as possible.

Municipal Plants for Peak Loads.

Supposing a municipality can buy more cheaply in bulk than they are able to manufacture, then the question may be asked, what are they to do with their existing electric plant? One reply to this is, use it as a stand-by for the peak loads. The great object of a Power Company is to attain to a 100 per cent. power factor, but except for electro-chemical and metallurgical industries this is practically impossible. The nearer they can get to it, however, the better they will be pleased, and it is conceivable, therefore, that a Power Company might make an arrangement with small municipalities whereby they supplied the bulk of the energy at a specially low rate in consideration of the municipal plants being brought into use to take care of the peaks.

A case where this would appear to work out very well would be a seaside town having an exceptionally busy season during June, July, and August. Such a town might very well buy a certain amount of electric energy at a specially low yearly rate, and only run their own boiler and engine plant during the three busy months. This would suit the Power Company very well, and they would be able to make a specially low offer for current in bulk, as they are able to do to a factory or electro-chemical works.

Opposition to Power Bills.

It seems to be the fashion for municipalities to systematically oppose Power Bills. For example, in the case of the Cleveland and Durham Electric Power Bill, the Corporations of Darlington, Stockton, Middlesbrough, and the Hartlepools did their best to be excluded, but were unsuccessful. Also in the case of the Somerset Power Bill, the Bristol authorities wished to exclude that city, but were badly beaten in both Houses. Rhyl and St. Asaph managed to be excluded from the area of the North-Western or Cheshire Power Bill, but the only result has been that they are incorporated in the area of the North Wales Power Bill. Now all this legal fighting in connection with Power Bills costs money, and it is money for which there is nothing to see but a few briefs and a blue book or two. The writer sometimes wonders whether ratepayers are really cognisant of what is done in their name. For example, how many business or tradespeople would support a movement, the object of which is to prevent them buying in the cheapest market? Yet this, as a matter of fact, is what opposition to most Power Bills really amounts to. If a municipal station can generate and distribute electrical energy more cheaply than a Power Company, then they cannot very well be harmed by the competition of such a company. On the other hand, if a Power Company can supply more cheaply, it will pay municipalities to take their supply from them in bulk.

Variation of Output from Water Power Stations.

Central electric power stations which use water power have usually a shortage of water at some period of the year, and an over-abundance at others. The time of the shortage varies according to circumstances; thus in Switzerland and some other mountainous districts, where snow water is the main supply, the shortage occurs in late winter, when many of the smaller streams become frozen. The largest supply is in early summer, when the snow is being melted rapidly. Now a Power Supply Company using water under such conditions can only enter into obligations with surrounding municipalities, railways, factories, etc., for the amount of power represented by the minimum supply of water under ordinary circumstances, therefore the flush of water during the greater part of the year goes to waste. In order to prevent this it has been suggested that water power stations should own and run an electro-chemical or metallurgical industry in conjunction with the generation of power. Suppose, for example, that in a certain case there is 50,000 water horse-power available for nine months in the year, and only 30,000 horse-power for three months. Then such a station would enter into the usual obligation to supply light and power up to the 30,000 horse-power capacity, and it would run its own affiliated company for the manufacture of aluminium, carbide of calcium, or other electro metallurgical product with the extra 20,000 horse-power. The factory would, of course, be organised on the basis of a nine instead of twelve months' run.

Design of Buckets for Tangential Water Wheels.

Much time and thought has been expended on the design of buckets for tangential or Pelton wheels. Starting from the wooden blades used on the old hurdy-gurdy wheels of the Californian gold boom days, the first step was to make cast iron blades scooped out slightly and mount them on the wooden wheel, then came the double rows of buckets, and an all-metal wheel, and then the divided bucket as we know it to-day, with a single nozzle playing on to the central dividing edge. It might be thought that there would not be much in the actual contour of the bucket, but judging from the number of patents which have been taken out, there is a great deal in it.

Clearly the ideal to be aimed at is a bucket which receives the stream in a solid condition, reverses its direction without breaking it up into spray, and discharges it along natural lines in an even flow over the whole bucket surface. Its form must be such that the plane of the bucket at the edge of the dividing wedge is always perpendicular to the direction of the stream, whilst every effort must be made to minimise friction between the stream and the surface of the bucket. The Ellipsoidal Bucket appears to be considered to approach nearest to these conditions.

SHIPBUILDING NOTES.

American Shipping Schemes.

Since last month's Notes were written the American Congress has adjourned after dealing with shipping affairs in a fashion that will not benefit this country. All idea of passing a Ship Subsidy Bill was abandoned for this Congress after the death of Senator Hanna, and the project will now lie over until after the Presidential Election. For the same political reasons the measure introduced by Mr. Sulzer, for imposing penal duties on goods imported into the United States in other than American bottoms, was hung up. But the measures which found favour and passed through both Houses were those introduced by Senator Frye—himself a warm advocate of subsidies to revive the American mercantile marine. One of these measures provides that all stores for the American Army and Navy shall be carried only in American vessels, except in cases of great emergency, when the President may exercise a discretionary power. The second measure is for extending the coastal navigation laws of the United States to the carrying trade between the United States and the Philippines. Senator Frye proposed to restrict that trade as from July 1st, 1904, but the House altered it to July 1st, 1906, because it was alleged that there were not enough vessels under the American Flag at present capable of undertaking this ocean trade unless these are withdrawn from the Atlantic. The two years were stipulated in order to enable American shipbuilders to prepare to take over an important and interesting branch of traffic hitherto very largely in the hands of British shipowners.

American Monopolisation.

It is idle to ignore the significance of this movement on the part of America. It is part of the policy that has already closed the shipping trade with Hawaii and Porto Rico against British shipping, and that will presently close the trade with Cuba. That a voyage from San Francisco round Cape Horn to New York should be deemed a coasting voyage under the Navigation Laws, and therefore strictly reserved for vessels on the American Register only, has long been an anomaly. It is now worse that a voyage from Manila to New York should also be accounted a coasting voyage open only to the American Flag. But it is all part of the policy to give an impetus to American ship-building and ship-owning. The latest proposal is to extend the American Coasting Laws to the zone of the Panama Canal. This was before Congress in a Bill introduced by Mr. McComas. It did not get through before Congress adjourned, but it was warmly applauded in the American shipping papers; and as more will be heard of it we give here its provisions:—

"That from and after the time of the possession and occupation on behalf of the United States of the canal zone of Panama, and until the construction and completion of a canal connecting the waters of the Atlantic and Pacific Oceans, the Act to regulate shipping in trade between ports of the United States and ports or places in the Philippine archipelago, between ports and places in the Philippine archipelago, and for other purposes approved April, 1904, so far as applicable, shall apply and be in force between ports of the United States and ports or places in the canal zone of Panama and between ports or places in the canal zone at Panama as fully and in the same manner as if the canal zone at Panama were included in the terms and provisions of said Act: Provided, That the sections and provisions of said Act limiting the time for the same to take effect on the first day of July, 1906, shall be applicable to the ports and places in the canal zone on the first day of July, 1905."

Subsidies for British Shipping.

The Select Committee on Ship Subsidies, it may be recalled, reported against any system of subsidies to British shipping, other than for services rendered. But they also declared that cases occur where, in view of Imperial considerations, subsidies are or may be necessary for establishing fast direct British communication, where such communication cannot be maintained on a commercial profit. As an illustration, East Africa was mentioned as a region where there is no direct British steamship service, and where British trade is handicapped by foreign subsidised steamship lines. There the matter seemed to rest, but at the beginning of May Mr. Evelyn Cecil, who was Chairman of the Subsidies Committee, drew the attention of Parliament and the country to it by asking the Chancellor of the Exchequer whether, in view of the fact that His Majesty's Government have assented in principle to the policy of subsidising a direct British steamship service to East Africa, and intimated that a Committee would be appointed to consider the details, he could now state the terms of the reference to the Committee and the names of its members. The Chancellor of the Exchequer replied that His Majesty's Government have assented in principle to the recommendation of the Select Committee on Steamship Subsidies in regard to the British service to East Africa, but these recommendations cannot be acted upon in the present state of the finances. In the meantime, the Government propose to appoint a Departmental Committee to work out the details. He was not then in a position to give the names of the Committee, but it will be composed of representatives of the Treasury, Foreign Office, Colonial Office, Admiralty, Board of Trade, India Office, and Post Office. The reference will be to inquire and report as to (1) what conditions should be prescribed for such a service; (2) what subsidy is likely to be required; and (3) what contribution may be expected from the British possessions and Protectorates interested in the scheme. The Committee will also be at liberty to make suggestions or recommendations on the questions generally, not specifically, falling under these heads. It is a matter for India whether it will contribute or not, but the India Office will be represented.

British Shipbuilding.

There has been a pause in the ordering of new steamers in the second quarter of the year—fortunately for ship-owners with tonnage in the water. Still, the new work booked has been considerable. According to the "Glasgow Herald," the launches from Scotch yards in the four months ending April 30th were 8,193 tons more than in the corresponding four months of last year, whilst the new contracts booked showed an increase of 9,190 tons. Put in another way, the contracts at the beginning of May were 55,377 tons more than the launches during the four months; while last year at the same date the contracts were 14,326 tons more than the launches. But in the 1904 contracts was included the leviathan Cunarder to be built by John Brown and Co., Ltd., after two years' negotiations. These Cunard contracts are the event of the shipbuilding year on Clyde and Tyne. The other feature of the shipbuilding industry is the development of the turbine motor for steamers.

Turbines.

Another turbine steamer has been launched by William Denny and Brothers, Dumbarton, viz., the *Londonderry*, built for the new Irish Channel service of the Midland Railway Company. The naming ceremony was performed by Mrs. Tilney, daughter of Sir E. Paget, Chairman of the Railway Company. The *Londonderry* is 330 ft. in length, 42 ft. in breadth, 18 ft. in depth to upper deck, and 25 ft. 6 in. to promenade deck. She is built of mild steel to scantlings approved by the Board of Trade, and is amply sub-divided by water-tight compartments. The first-class accommodation is situated amidships, and the third-class between the main and mizzen hatchways, while accommodation is provided for drovers at the after end of the vessel. Above the promenade deck amidships there is a shade deck, which forms a promenade for first-class passengers in fine weather, and shelters the deck below during rain. The first-class accommodation is in a large deck-house, and consists of private cabins, having one, two, and four berths. On the upper deck there are a number of one, two, and four-berth cabins. The dining saloon is on the deck below, immediately forward of the boiler room. The accommodation for third-class passengers marks a considerable advance on the ordinary Channel steamer, there being a number of separate four-berth state-rooms, in addition to a large saloon. The vessel has a balanced rudder of a type similar to that fitted in Denny's other turbine vessels, and is steered by means of a steam tiller controlled from the flying bridge by a telemotor. The vessel is ventilated on the thermo-tank system, which secures a supply of suitably warmed air driven by electric fans through trunks to all compartments of the vessel. After the launch, Mr. James Denny said the Midland Railway Company had acquired on their own account a railway system in the north of Ireland, and it was natural they should wish to have a share of the profit out of the ever-increasing trade between England and Ireland. About a year ago they came into the market for four new steamers. At first it was intended that the steamers should be fitted with ordinary machinery, but later on it was decided that two should be fitted with turbines, and two with reciprocating engines. The comparative results would be viewed with very great interest by all concerned. They had no reason to doubt that the *Londonderry* would be successful, because only a few days ago they had been having official trials with the *Princess Maud*. According to the terms of their contract for that vessel, they had to do 20 knots on a double run between the lights, and this with a restricted air pressure and the use of Scotch coal. The result of the trials was that, instead of 20 knots, they got 20·7. He did not think, however, that quite represented what was in the vessel, because on the second part of the run his partner, Mr. Henry W. Brock, who was in charge of the machinery, found himself embarrassed from the unusual cause of having too much steam. He had to let some out of the engines to allow them to run faster, with the result that in the second half of the trial, and allowing for the considerations of tide, wind, and sea, the speed of the boat came to nearly 21 knots. Had it been a matter of necessity, they would not have had much difficulty under the trial conditions of realising that as the mean speed, because the air pressure they were allowed to have was never even approximately approached. He hoped the *Londonderry* would be an equally successful steamer.

Legislation.

The Merchant Shipping Bill introduced into the House of Lords by Lord Wolverton has been prepared to give effect to the recommendations of a Departmental Committee appointed by the President of the Board of Trade in January, 1902, to consider certain questions affecting the mercantile marine. The report of the Committee was presented to both Houses of Parliament. If the Bill becomes law every British foreign-going ship of 1,000 tons gross leaving a port in the United Kingdom will be required to have on board a competent cook in the same way as such a vessel is compelled to have on board properly certificated officers. The Royal Commission on Labour recommended in 1894 that "some qualification should be required from ships' cooks." The rights of men now serving at sea as cooks are safeguarded by the recognition of certificates of discharge as cook for two years previous to December 31st, 1907, as equivalent to certificates of competency. It is proposed to extend the application of the provisions of Section 206 of the Merchant Shipping Act, 1894. Under that Section all ships going from the United Kingdom through the Suez Canal or round the Cape of Good Hope or Cape Horn have their provisions inspected before departure. The system of inspection will not be extended to require all foreign-going ships to submit their provisions to inspection, but the inspectors of ships' provisions will have power to inspect, if they think fit, the provisions of any British foreign-going ship, the duration of whose voyage is likely to exceed twenty-one days. Clause 3 proposes to ensure in the interest of the greater safety of ships an adequate knowledge of the English language on the part of seamen engaged in the United Kingdom. Imprisonment for failure to join a vessel after signing articles was abolished within the United Kingdom by the Merchant Seamen (Payment of Wages and Rating) Act, 1880. In order to provide a deterrent for such an offence without reverting to imprisonment, it is now proposed to give power to the Board of Trade to withhold for a short period, in a proved case of wilful failure to join, the seaman's certificate of discharge.

IRON AND STEEL NOTES.

By E. H. B.

The Iron and Steel Institute.

If any proof of the vitality of the Iron and Steel Institute were needed, it would be found in the ever-growing output of its literature, which, at the recent meeting, was represented by a batch of papers sufficient to make quite a respectable volume. Again, from the annual report, I observe that during the year, two cloth-bound volumes of the Journal of the Institute have been published, containing together 1,660 pages of letterpress, 81 plates, and numerous illustrations in the text. This amount of printed matter is in excess of that published in any previous year. In addition to the papers read before the Institute, and the discussions and correspondence relating to them, these volumes contain abstracts of 2,314 papers relating to iron and steel and kindred subjects published in other home and foreign Journals and Transactions. The list of members was issued separately in the form of a pamphlet of 118 pages; and the Institute has also reprinted Bunsen and Playfair's report on the gases evolved from iron-furnaces, the reprint covering 76 pages. Thus during the year the members received 1,854 pages of printed matter.

"Taken as Read."

Although the meeting was essentially for business purposes (with the indispensable exception of the dinner at the Hotel Cecil), it was found impracticable to read more than a few of the papers presented, and many members must have left London with a feeling that though the meeting had proved a very interesting one, a great deal of useful discussion had been abandoned from sheer lack of time. Not even the energy and solicitude of a master of detail like Mr. Brough, nor the exceptional experience as chairman of Mr. Carnegie, can avoid an *impasse* of this kind under the present system. It is to be presumed, however, that the Council might frame rules which would improve the procedure followed. If every author would present a brief abstract of his paper—some do already—there would be far more time for discussion, and it would in no way detract from the value of the papers. At least one of the papers at the recent meeting was read at a speed which rendered it extremely difficult to hear the author perfectly, much less to follow his arguments. The *reading* of papers aloud *in extenso* always seems to me to entail a waste of valuable opportunity, and I cannot help thinking that the Institute would find it profitable to give more encouragement to abstracts. The papers "taken as read" included a great deal of valuable and suggestive matter.

Iron for Lofty Structures.

Mr. Thwaite's paper on the "Use of Steel in American Lofty Building Construction" was more particularly interesting, because it was based upon facts gathered by him in a very recent tour in the United States. I do not for a moment suppose that Mr. Thwaite would like to see "flat-irons" and such-like structural abominations blocking out the already insufficient light of our London streets, but the American method of going to work in order to insure rapidity of construction undoubtedly offers a useful field for study, and the use of steel in structures has, of course, a most important bearing upon the question of fire-protection. On the whole, I venture to think that Mr. Thwaite has done a useful service in bringing this question once more before the members of the Iron and Steel Institute. As he points out—if the method is at all extensively adopted in this country and in Europe, it cannot fail to benefit every branch of the industry.

The Key to the Bessemer Process.

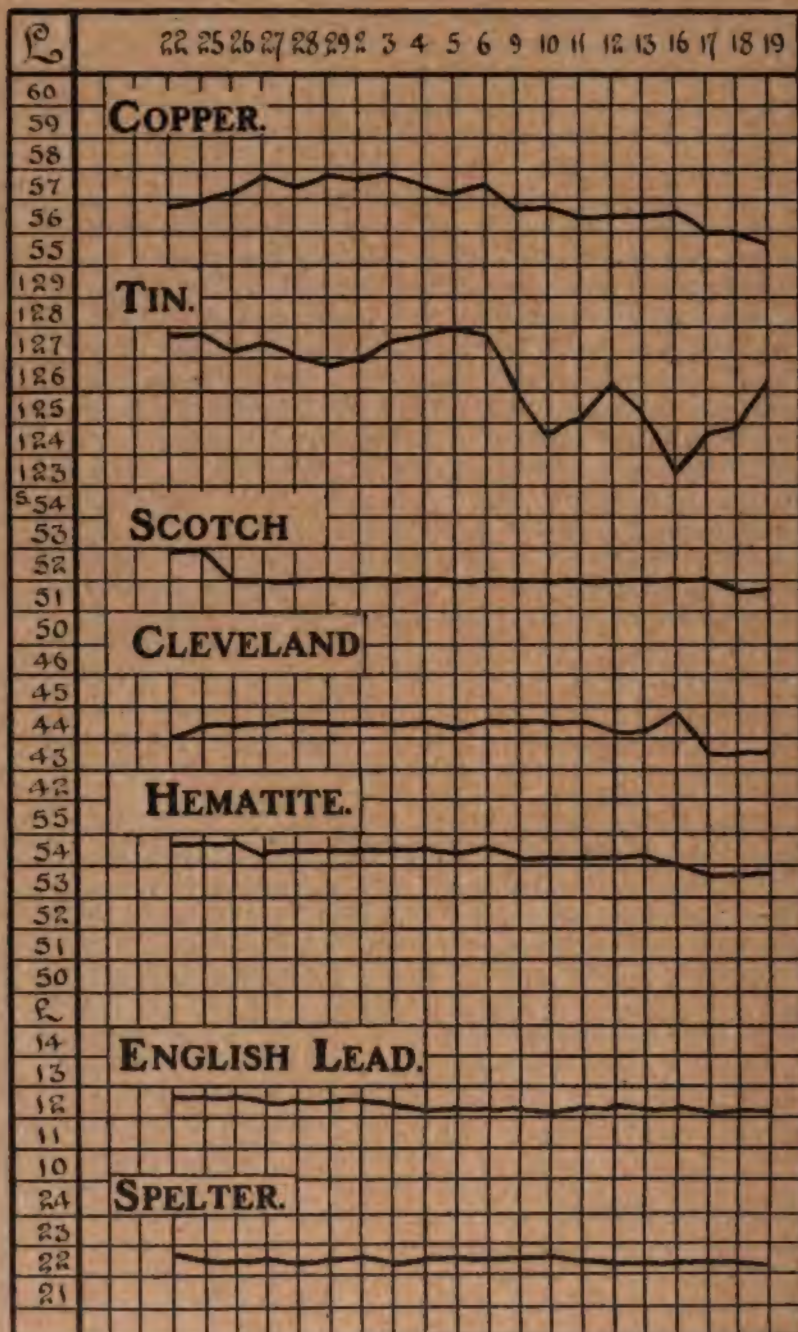
Mr. F. J. R. Carulla's paper on "The Synthesis of Bessemer Steel" was written in the hope that a discussion might help to bring about any improvement in the process that new conditions may have rendered necessary. The author relates how, on "coming to grips" with the synthesis of Bessemer steel, he felt the need of some "key" to the situation that the management of the carbon did not give. This was found in the proper employment of the manganese. The author's experience had been leading up to this, for he had already found that by proper manipulation of the manganese, sound ingots free from honeycombs could be obtained. As direct rolling was being introduced, this was a most important matter. By using the exact quantity of spiegel to introduce 1·35 per cent. of manganese into the charge, his object was most successfully accomplished.

To satisfy not only the rail-mill manager but also the tire-mill manager, and the forge manager who had to use it for axles, every one of them pronouncing it "the best steel ever made," was enough to make one think that the "key" had at last been found.

The percentage of manganese depends, of course, largely on the chemical composition of the charge. Tables are included showing the mixtures successfully employed by the author.

Other Papers "taken as Read."

The other papers "taken as read" included Mr. Henry Cook Boynton's careful statement of his inquiry into the nature of "Troostite," made in the laboratories of Havard University, and Mr. Walter Rosenhain's contribution on the "Plastic Yielding of Iron and Steel" (valuable to those engaged in the field of physical metallography), while Mr. W. J. Foster stated the results of some careful observations on "Blast Furnace Efficiency at Darlaston," Mr. Percy Longmuir presented his investigations on "The Influence of Temperature on Steel and Iron Castings," and Mr. Pierre Breuil contributed a paper on "The Effects of Slowly Applied and Suddenly Applied Stresses."



THE HOME METAL MARKET.

Chart showing daily fluctuations between April 22nd and May 19th, 1904.

LOCOMOTIVE ENGINEERING NOTES.

BY

CHARLES ROUS-MARTEN.

More "Atlantics."

The Great Western has joined the steadily growing list of British railways that build locomotives of the "Atlantic" or 4-4-2 type. As a matter of fact, the type already exists on that line, in the case of the du Bousquet de Glehn compound, "La France." That, however, may be regarded as a sort of exotic, whereas the new "Atlantic" will be purely of British growth. I understand it will have outside cylinders, and the very long piston-stroke—30 in.—favoured by its designer, Mr. G. J. Churchward. Details are not yet available, but from the information that has reached me I gather that the new engine will be virtually an "Albion," with a pair of small carrying wheels behind the firebox, instead of the third pair of 6 ft. 8 in. coupled wheels. If so, that should be an admirable design for Great Western work, assuming, of course, that the extra-long piston-stroke proves in actual practice an advantageous innovation.

Quasi-Compound.

Talking of the 30-in. piston stroke, it may be worth while to point out that this provides a species of quasi-compounding. It might almost, indeed, be termed Mr. Churchward's system of compounding, or, at any rate, of obtaining some of the advantages of the compound method without duplication of the cylinders and distributing gear. For the main essence of the compound principle consists in the double expansion of the steam, which, after being used in the high-pressure cylinder, or cylinders, is discharged into the low-pressure cylinder or cylinders, and expanded over again. Sometimes the high-pressure and low-pressure cylinders are placed one in front of the other, tender-wise. What Mr. Churchward does is in a sense to take the tandem method, but to knock the two cylinders into one, and do all his steam expansion in that one cylinder. He takes his 18-in. by 26-in. cylinders as used in his "City" class, and adds another cylindrical length, still 18 in. in diameter, and in that length he gets his extra expansion of the steam, while at the same time he obtains the increment of mechanical power which the enhanced leverage of the longer stroke affords. It is in short, a revival of the idea that the advantage of compounding may be obtained by the cheaper method of cylinder enlargement, only Mr. Churchward enlarges his cylinders longitudinally instead of diametrically; that advantage was claimed in 1884 on behalf of the 19-in. cylinders which Mr. S. W. Johnson, on the Midland, and Mr. J. Stirling, on the South-Eastern, gave to their "1667" and "116" classes respectively. But the difficulty then experienced was to train the drivers to obtain the full advantage of the opportunity offered of working expansively, failing which the engines were run "out of breath." The expansion lengthways seems to offer a better chance of utilising the full power of the steam, provided that the extra length of stroke be not found disadvantageous at high speeds. But the full value will necessarily depend in a large measure on the personal equation of the driver, and it has yet to be proved whether the additional length of cylinder be an adequate substitute for compounding in its ordinary form. The experiment is a most valuable and interesting one.

The Great Western Record Run.

Before quitting the Great Western I ought to mention briefly the brilliant performance accomplished by that railway on May 9th, when the American and New Zealand mails were delivered in London in the unprecedentedly short time of 5 days 21 hours 58 minutes from New York! The Great Western's part in this achievement was duplex, consisting in two separate runs with two different engines and classes of engines, with two different loads, and on two different classes of roads. The first stage, viz., from Plymouth to Bristol, 128¾ miles in length, starts on a grade of 1 in 50, and then has a rise of 15 miles to Wrangaton, beginning with 2½ miles as steep as 1 in 41. There is a second but shorter climb to Dainton, with such grades as 1 in 43, 1 in 41, and even 1 in 40. After Exeter, there is a 20-mile ascent to Whiteball tunnel, the last 2½ miles at 1 in 115. The rest of the road is easy. On this stage one of Mr. Churchward's "City" class, No. 3440, "City of Truro," with 6-ft. 8-in. four-coupled wheels and inside cylinders, 18 in by 26 in., was employed. This engine, well driven by Clements, maintained a minimum rate of 27 miles an hour up the bank at 1 in 41, and "rushed" the shorter bit of 1 in 40 without going slower than 34·6 miles an hour, while up the 2½ miles of 1 in 115 the rate was never lower than 63. The speeds on the falling grades and levels were very high. Exeter was passed in 55 min. 55 sec., from Plymouth North Road, a distance of 52 miles, in which the exceptionally severe grades already mentioned occur. The next length, from Exeter to Bristol (Pylle Hill Junction), 75½ miles, was covered in the remarkable time of 64 min. 17 sec.; from the Exeter pass at walking pace to the dead stop, averaging 70.2 miles an hour, while the entire run of 128¾ miles from the absolute start at Millbay Dock Crossing was done in 2 hrs. 3 min. 19 sec. The load behind the tender was 148 tons, not a heavy one, of course, but still equivalent to one of 296 tons if worked by two engines.

A Brilliant Veteran of Archaic Type.

At Bristol the engines were changed, and the load was reduced to 120 tons by detaching the mail van for Bristol and the Midlands. The fresh locomotive was one of Mr. W. Dean's 7 ft. 8 in. single-wheelers, with inside cylinders, 19 in. by 24 in., an ideal type for very swift running with a light load. At the same time it must be remembered that the load was equal to one of 240 tons, if taken by two engines. No. 3065, "Duke of Connaught," smartly driven by Underhill, made the run of 118¼ miles from Bristol to London in the extraordinary time of 99 min. 18 sec. to the Paddington platform, or 99 min. 46 sec. to the final stop. The 107 miles from Bath occupied 85 min. 40 sec., and the 77¼ miles from Swindon 59 min. 41 sec., although it was necessary to slow down almost to walking pace over a bridge under repair just east of Swindon. The

time from that bridge to Paddington, 76 miles 47 chains, virtually a start to stop run, was 58 min. 47 sec., and the distance of 81 miles 50 chains from Wootton Bassett to Westbourne Park occupied only 62 min. 55 sec., in spite of the dead slowing over that bridge and the slackening for London. The time from passing Reading to stopping at Paddington, a distance of 36 miles, was 27 min. 18 sec., and the average speed from Bristol to London, start to stop, was 71·3 miles an hour. Both engines arrived in perfect trim and with bearings entirely cool. The coal consumption was estimated at 32 lb. per mile on the first and much heavier stage, 30 lb. per mile on the second. The coupled engine used 180 lb. steam pressure, the single-wheeler 160 lb. The observations of work were made by myself personally, but, of course, I had no means of checking the fuel consumption.

A London and South-Western Record.

Another record run from Plymouth to London in connection with the steamship services from America was accomplished on April 23rd by the London and South-Western Railway. In ordinary circumstances, stops are made at Exeter and Salisbury, but in this instance it was arranged to change engines at Templecombe, a point 117½ miles from Plymouth, and 112½ miles from London, therefore a good "half-way house." The road is a very heavy one throughout the first stage, Dartmoor being climbed by many miles of 1 in 73 to 1 in 77, while even after Exeter long banks at 1 in 90 and 1 in 80 are met with. In this stage No. 399, one of Mr. D. Drummond's new class specially designed for that section was used. It has four-coupled 6-ft. wheels, inside cylinders 19 in. by 26 in., and 175 lb. steam pressure, also Mr. Drummond's patent water-tube fire-box. Pearce was the driver. The Dartmoor grades were very smartly climbed by No. 399, the speed being generally maintained at 40 miles an hour or upward. It only once dropped so low as 36, and promptly recovered to 40. The last 22½ miles to the summit, most of which is steeper than 1 in 80, occupied only 30 min. 58 sec. Up the banks at 1 in 80 and after Exeter the minimum was 45. The falling gradients were descended at a very moderate rate in order to secure as uniform a movement as possible, so the run of 117½ miles to the Templecombe stop occupied 134 min. 53 sec., or from Devonport station 133 min. 32 sec., but could have been done in much shorter time had high downhill speeds been employed. From Templecombe to London one of Mr. Drummond's standard class engines, No. 336, with 6-ft. 6-in. coupled wheels, and cylinders 18 in. by 26 in., was used, Gare being the driver. On this stage very high speeds were maintained. Up the bank at 1 in 165 near Porton, the speed never went below 55·8 miles an hour, and up the 1 in 178 near Whitchurch the minimum was 64·2. The total run of 112½ miles from dead start to dead stop occupied 104 min. 33 sec.; from Templecombe platform to Waterloo platform 103 min. 43 sec., averaging 65 miles an hour throughout. The time from Salisbury to Waterloo, 83¾ miles, was 76 min. 30 sec.; from Basingstoke to Waterloo, 48 miles, 42 min. 33 sec. From a dead stop by signal in St. David's Station, Exeter, to the final arrival at Waterloo, the time was 3 hrs. 53 min. 48 sec. for the 172 miles, and from the Exeter station of the London and South-Western—passed at dead slow—to the London stop occupied only 3 hrs. 49 min. 39 sec., the distance being 171¾ miles. The complete inclusive journey from Stonehouse Junction, Plymouth, took 4 hrs. 3 min. 11 sec., and from Devonport station (Plymouth) to Waterloo station (London), 230 miles, the actual travelling time—excluding the Exeter and Templecombe stops—was 3 hrs. 58 min. 17 sec. Altogether it was a very fine performance. The load behind the tender was approximately 105 tons.

A London and North-Western Record.

In such a period of "records" it would have seemed incongruous were England's premier railway to be "out in the cold," and I am glad to be able to register another record—this time to the credit of the London and North-Western Railway. On May 2nd, the best times between London and Manchester each way were reduced by 15 minutes, *i.e.*, to 3 hrs. 30 min. for the 188½ miles *viâ* Crewe, the trains running each way without stop between Euston and Stockport, 183 miles. The inaugural run was made by a "relief" to the 10.35 a.m., which, after starting from Euston, passed the Tring summit in 36 min. 16 sec., Rugby 83 min. 48 sec. from dead start, or 82 min. 59 sec. from the Euston platform, 82½ miles; Stafford in 136 min. 14 sec., from the start, 135 min. 25 sec. from platform, 133½ miles. The train was checked by a Scotch express in front during the last 10 miles to Crewe, where a special stop by signal was necessitated, 2 hrs. 45 min. 56 sec. from Euston, distance, 158 miles. Stockport was reached in 3 hrs. 15 min. 52 sec., start to stop, 3 hrs. 14 min. 24 sec., platform to platform. Finally, the arrival at Manchester was in 3 hrs. 26 min. 50 sec., start to stop, or 3 hrs. 15 min. net. The train, reckoned as "11½ coaches," and estimated to weigh 220 tons behind the tender, was drawn by two engines, a 7-ft. 6-in. single-wheeler, with outside cylinders 16 in. by 24 in., dated 1862, and a 6-ft. 6-in. coupled, with inside cylinders 17 in. by 24 in., dated 1882. The load was, therefore, 110 tons per engine. The up journey was marred by a special stop of 4 minutes at Stafford for water and a pilot, and by a loss of 5 minutes in the running to that point. From Stafford, however, a very smart run of 2 hrs. 15 min. 19 sec. was made to Euston, nearly 7 minutes being gained. The engines were a "Jubilee" compound and a 6-ft. 6-in. coupled non-compound. The actual travelling time from Manchester to Euston was 3 hrs. 26 min. 50 sec. Similar work is now done daily.

A Great Central Feat.

Several experimental trips with Mr. J. G. Robinson's newest and very fine Great Central ten-wheeled engines have given me some most interesting results, in the case both of the "Atlantics" and of the "4-6-0" types. Space, however, will only permit my mentioning a single performance by one of the latter class, which for smartness in starting and in attaining speed, has certainly seldom if ever been beaten. Being stopped by signal at Charwelton, we got away again so briskly that when we were again stopped by signal at the next station, Willoughby, we had covered the intermediate distance of 7 miles 3 chains in 7 min. 39 sec., start to stop. Next we were almost stopped again by signal at Ashby, but leaving that station dead slow we actually ran thence to the dead stop at the entrance to Leicester station, a distance of 9 miles 10 chains, in the amazing time of 7 min. 49 sec., attaining a rate of 86·5 miles an hour just before steam was shut off. The engine has six-coupled wheels 6 ft. 9 in. in diameter, leading bogie, outside cylinders 19 in. by 26 in., and 1,911 sq. ft. of total heating surface. The load was light, only 130 tons behind the tender, and the line was mostly on a falling gradient of 1 in 176; still, even so, the feat was a splendid one.

THE CIVIL ENGINEER AT WORK.

By C. H.

New Cableway in the Andes.

The longest cableway in the world will be that which is shortly to be installed on the Argentine side of the Andes by Messrs. Adolf Bleichert and Co. This cableway will extend from Chilectio Station, on the Argentine Northern Railroad, which is 3,430 ft. above the sea, for a distance of twenty-two miles, to a point 14,933 ft. above the sea level, or 1,300 ft. higher than the summit of the Jungfrau.

The Institution of Civil Engineers.

At the annual general meeting of the Institution of Civil Engineers, the result of the ballot for the election of council for the sessional year 1904-5 was declared as follows: President, Sir Guilford L. Molesworth; vice-presidents, Mr. F. W. Webb, Sir Alexander Binnie, Mr. Alex. B. W. Kennedy, Mr. W. R. Galbraith; other members of council, Mr. C. N. Bell (Wellington, N.Z.), Mr. C. A. Brereton, Mr. R. Elliott-Cooper, Colonel R. E. B. Crompton, C.B., Mr. W. J. Cudworth (York), Mr. G. F. Deacon, Mr. F. Elgar, Mr. R. Hadfield (Sheffield), Mr. G. H. Hill, Mr. C. W. Hodson (Bombay), Mr. J. C. Inglis, Mr. G. R. Jebb (Birmingham), Mr. T. C. Keefer (Ottawa), Mr. A. G. Lyster (Liverpool), Mr. J. A. McDonald (Derby), Mr. W. Mathews, C.M.G., Sir Charles Metcalfe (Cape Town), the Hon. C. A. Parsons (Wylam-on-Tyne), Mr. A. Ross, Mr. W. Shelford, C.M.G., Mr. Alexander Siemens, Mr. John Strain (Glasgow), Sir John I. Thornycroft, Professor W. C. Unwin, Sir Leader Williams (Manchester), and Mr. A. F. Yarrow.

The following awards for papers read and discussed before the institution during the past session have been made by the Council:—A Telford gold medal to Major Sir Robert Hanbury Brown; a George Stephenson gold medal to Mr. G. H. Stephens, C.M.G.; and a Watt gold medal to Mr. Alphonse Steiger; Telford premiums to Mr. E. W. De Rusett, Dr. Hugh Robert Mill, Mr. Alexander Millar, and Mr. T. E. Stanton; a Manby premium to Professor J. Campbell Brown; and a Crampton prize to Mr. L. H. Savile.

The Great Northern, Piccadilly, and Brompton Railway Works.

On Thursday evening, May 12th, a visit was paid by the Junior Institution of Engineers to the Great Northern, Piccadilly, and Brompton Railway Works, the party numbering about one hundred. They were received on behalf of the engineers, Sir James Szlumper and Mr. W. Szlumper, by Mr. A. F. Baynham, resident engineer of the South Kensington to Holborn section. Mr. Price was also present on behalf of the contractors. The works were commenced in the early part of 1902, and are in operation throughout the whole of the line, more than half the tunnelling having been completed. The ordinary "Greathead" shield was used to commence with, but after the works had been in progress for a short time an improvement on it was made by fixing an electrically-driven excavating wheel at the face of the shield, which obviated the necessity of the clay being excavated by hand to permit the shield to push forward. This appliance has proved to be a great success, and is now in use over the whole of the line. With the original "Greathead" shield, the maximum number of tunnel rings completed in any week was about forty, whereas with the new rotary excavating machine as many as seventy-two rings have been inserted per week.

The Panama Canal.

According to the "World's Work," about two-fifths of the Panama Canal is already cut, including fourteen miles from the Atlantic coast and four miles from the Pacific coast; but these sections will need deepening. Thirty-six miles of the most difficult part remain to be cut. It is estimated that this task will require the work of 50,000 men for eight years. A great dam is to be built at Bohio, which is fourteen miles inland from the Atlantic coast, that will make a lake fifty-two feet above the Atlantic, into which vessels will be raised by locks. The new level thus reached will extend twenty-two miles. Then vessels going toward the Pacific will descend by locks about sixty-five feet; farther on they will descend again perhaps thirty feet, to the Pacific level. The dam will supply power that will be used in excavating, and the work under American direction is expected to go on much faster than the French company conducted it.

Automatic Signalling on Railways.

A "Times" correspondent records that the automatic signalling apparatus, which has been installed on the main line of the North-Eastern Railway between Alne and Thirsk by the Hall Automatic Signalling Company of New York and Chicago, has been duly put into service. The decision to instal this section of the line in this manner was arrived at as a result of the visit paid by the principal officials of the company to America, where they saw the system in full operation on the Lehigh Valley and other lines, on which it has been used for many years with admirable results. The system is one of electric control and mechanical operations. Each signal column is fitted with a small apparatus operated by carbonic acid gas for lowering the semaphores. The mechanism is set in motion by an electric current conveyed to the signal columns by track batteries which are operated by the passage of the trains over the metals, all of which have been bonded and supplied with a current of electricity. While a train is on a section it cuts off the current from the columns and holds the semaphores of two sections to its rear at danger, and no succeeding train can get a clear signal until its predecessor has passed over two sections in front of it. There is an additional element of safety provided by the fact that the normal position of the signal will always automatically be at danger, so that in the event of any train meeting with a mishap it holds the line for two blocks behind at danger, it being impossible for a train to enter those sections except in the face of the signals.

The Simplon Tunnel.

To celebrate the opening of the Simplon Tunnel, an exhibition will be held in the Town Park at Milan during the year 1906, under the patronage of H.M. the King of Italy. Amongst the international exhibits there will be the following: Carriage by Land and Water, Aeronautics, Decorative Art, Handicrafts at Work, and Thrift.

AMERICAN RÉSUMÉ.

By Our New York Correspondent.

NEW YORK, May 19th, 1904.

Model Foundry at St. Louis.

According to the "Iron Trade Review," there has been some misunderstanding among foundrymen concerning the status of the project for erecting and equipping a model foundry at the St. Louis World's Fair. It may be said that while the original project for a building costing $50,000, to be erected with funds subscribed by various foundry and foundry supply firms, has been given up, the exposition authorities, through the Mines and Metallurgy division, of which J. A. Holmes is chief, will themselves provide the building which is now under way and will be practically completed by another week. Exhibits will be made by a number of foundry equipment and supply houses, manufacturers of moulding machines and others, and these will be arranged for in the way in which other exhibits are provided, the Exhibitor dealing with the Exposition officials. The exhibits are expected to be in readiness early in June, so that the American Foundrymen's Association, which goes to St. Louis on June 10th from its convention in Indianapolis, will find all in place. It is understood that the money subscribed in the canvass made on behalf of the New England, Philadelphia, and Pittsburg Foundrymen's Association will be returned.

The Origin of Petroleum.

Mr. Eugene Coste, in the course of a contribution to the transactions of the American Institute of Mining Engineers, claims that geology can to-day most clearly prove the origin of petroleum to be inorganic, and the result of solfataric volcanic emanations. He points out that in all the oil and gas-fields or petroleum deposits, the gaseous products are under a strong pressure which is not artesian or hydrostatic, which increases with depth, and which cannot be anything else but a volcanic pressure. The oil and gas-fields are located along the faulted and fissured zones of the crust of the earth, parallel to the great orogenic and volcanic dislocations.

Oil, gas, and bitumens are never indigenous to the strata in which they are found—they are secondary products impregnating and cutting porous rocks of all ages exactly as volcanic products alone could do.

Oil and gas are sorted products, in great abundance in certain localities, while neighbouring localities often are entirely barren; and many of the strata among which they are found are so impervious that the source of these hydrocarbons must be the volcanic source below, which alone is abundant enough, and alone possesses sufficient energy, to force and accumulate such large quantities of these and associated products in so many spots through such impervious strata. The numerous oil and gas-fields known to-day indicate plainly a considerable number of these oil-belts; but more remain to be discovered, and new ones are coming rapidly to the front, especially in the United States. The author has been at work ever since 1888 in mapping out these fissured zones of North America.

Mr. Ferrell on his Fire-Proofing Inventions.

The discussion which followed a paper by Mr. Joseph L. Ferrell, read before the Western Society of Engineers, has shown that the greatest interest is taken by American engineers in that gentleman's inventions in connection with the preservation of wood from fire and decay. The Ferrell processes were described in detail some months ago, in Page's Magazine by Sir Ralph Moor, K.C.M.G., who first became interested in the matter by reason of the immunity of the protected wood from the ravages of white ants. About two and a half years ago, said Mr. Ferrell, in reply to a questioner, I sent 300 ft. of treated wood to a captain in the English army in Africa, and also sent some to another English gentleman in India. They put the wood in the ant hills themselves, and left them buried there for two or three months, and they came out without being touched.

A member: "What wood did you use?"

Mr. Ferrell: "Yellow pine, white pine, and I think there were a few pieces of oak. As a result of that, Captain Kenneth Campbell and Sir Ralph Moore, of the English Government in India, heard of it, and when they came home they got into communication with some gentlemen in London, and made recommendations to the English Government."

Asked to mention instances in which his fire-proof enamel had been in use for some time, the inventor said he had very complete records. The material was practically as enduring as glass. There was no possibility of its decay. This enamel, however, was for indoor use. There was another form for outdoor use. He had one material which, as a filler, was of such penetrating power that it would go through a ½-in. board if floated and left over night, and this penetrating material was essentially a preservative, and fireproof as well.

In reply to a questioner who wished to know how long the processes had been on the market as a commercial factor, Mr. Ferrell said their patent work had kept them back for years. He had to take out fifteen patents in twenty-eight different countries, but some were exceedingly slow, and the patent solicitor forbade them to go ahead, and do anything, practically, except to use the machine for fireproofing wood. For this reason, so far as the fireproofing of the wood was concerned, they had only been able to work for about four years.

There was an important reference to the fireproofing of theatre scenery. Mr. Ferrell said that what he would recommend in theatres would be that all the floors be coated with a plastic material which was absolutely impervious to fire, with an additional flooring of not over ⅜-in. maple or oak, which had previously been saturated with sulphate of alumina. In this way a floor was simply and cheaply made fireproof beyond possibility to burn under any circumstances. In regard to fireproofing the scenery—the present treatment of a thin fabric to prepare it for water-colour painting—to make a size, in other words, upon which to use colour—was done with a preparation of glue and whiting. Glue was so exceedingly combustible that it was necessary to have some other substance to size the material. One of his processes provided completely for this.

Wood, textile fabrics, theatre scenery, etc., could be simply and most effectively treated so as to eliminate every possibility of their receiving or extending flame.

SOUTH AFRICAN RÉSUMÉ.

BY OUR JOHANNESBURG CORRESPONDENT.

Deep Level Mining Costs.

At the annual meeting of the Rand Mines, Ltd., held recently in Johannesburg, the chairman, Mr. L. Reyersbach, gave some interesting figures in the course of his speech, relating to the present mining costs and the economies in working which have been recently achieved.

The following statement shows the average cost *per ton milled* of treating 1½ million tons by nine deep-level companies on different parts of the Witwatersrand :—

A.	s.	d.
Mining expenses	13	9·060
Milling	2	10·299
Cyaniding	2	11·575
General expenses	2	3·189
Total	21	10·123

On account of the practice of sorting ore, the tonnage mined is, of course, greater than that milled, so that the cost of mining alone, reckoned on *the tons raised*, is only 13s. 1·209d., and is made up as below :—

B.	s.	d.
General maintenance of mine, etc. ..	0	10·124
Developing	1	4·514
Stoping	6	2·563
Shovelling in stopes	1	10·142
Tramming	1	1·789
Winding	1	2·299
Pumping	0	5·778
Total	13	1·209

Treatment Costs.

The details of the cost of milling, including delivery to battery, are as follows :—

C.	s.	d.
General costs	0	0·823
Ore sorting	0	1·736
Ore crushing	0	4·419
Ore transport	0	1·212
Milling	2	1·409
Retorting, smelting, and assaying ..	0	0·700
Total	2	10·299

This total is, of course, the same as the figure given in table A. The cost of cyaniding, calculated on the basis of total tonnage treated, would differ from the cost per ton milled, as given in table A, because some of the material is lost altogether after leaving the mill, and escapes subsequent treatment. Mr. Reyersbach states, however, that "almost 99 per cent. of the pulp leaving the mill passed through the different stages of the cyanide works," and gives the cost of treating the various products separately, thus :—

	s.	d.
Concentrates	5	3·522
Sands	2	10·252
Slimes	2	7·832

He also gives the average cost for all material cyanided as 2s. 11·075d.

The last item in table A is further sub-divided, thus :—

	s.	d.
General expenses at mine	1	5·414
Expenses at head office	0	9·775

Metallurgical Progress.

The next set of figures show the continuous improvement which has been maintained with respect to the total percentage extracted from the ore by the various methods of treatment at the Rand Mines subsidiary companies :—

Year.	Tonnage milled.	Average assay value, dwts.	Percentage recovered.
1897 ..	327,294 ..	12·508 ..	75·168
1899 ..	1,296,125 ..	11·543 ..	87·819
1903 ..	1,543,542 ..	9·247 ..	88·106

The figures in the last column refer to the gold actually recovered, and the best result returned by this group of companies was claimed by the Ferriera Deep, namely, 94·12 per cent. Incidentally, the above table also shows the great increase in the extent of the operations of this group of mines.

Reduced Cost of Explosives.

The termination of the Government monopoly for the sale of explosives in the Transvaal, and the competition of the De Beers factory in Cape Colony, which was referred to a few months ago, has led to a considerable reduction in the prices. For instance, the present price of blasting gelatine delivered at the magazines on the mines is now about 54s. per case as against 97s. 6d. per case in 1899. This means a reduction of about 1s. 3d. per ton milled, and will go a long way towards paying the tax of 10 per cent. on the profits.

Average Practice.

The following figures, also from Mr. Reyersbach's speech, give in a very concise form a fair idea of the average practice in many particulars of deep level mining on the Rand :—

	Tons.
Total ore mined by the nine companies	1,620,626
Taken from surface dumps	42,874
Total sent to sorters	1,663,500
Deduct amount of waste sorted out (average assay value, ·993 fine gold)	118,988
Balance sent to mill	1,544,512
Deduct difference in bins	970
Total tons actually milled ..	1,543,542

In crushing this, an average number of 880 stamps were running 348·344 days, therefore the duty per stamp was 5·035 tons per 24 hours.

It will be noted that the mean percentage of waste sorted out during the year was 7·15 per cent. :—

Original value of ore, 9·247 dwts. (fine).

Mill yield ..	4·974	=	53·972 per cent.
Cyanide works ..	3·173	=	34·134 ..
Total	8·147	=	88·106 per cent.

From the above figures, it follows that the average extraction of all the cyanide processes was 74·1 per cent., but the returns from the original and residue assays at the cyanide works show an actual extraction of 75·34 per cent.

GERMAN RÉSUMÉ.

BY

DR. ALFRED GRADENWITZ.

BERLIN, May 21st, 1904.

The Importance of Selenium to the Electrical Industry.

At a recent meeting of the Berlin Elektrotechnischer Verein, Mr. E. Ruhmer delivered an address on the above subject. After briefly explaining the properties shown by the various modifications of selenium, the design of the so-called selenium cells using the sensitiveness to light characteristic of the crystalline modification was dealt with. As by the increase in the conductivity of selenium, due to illumination, the current intensity in the circuit is altered, these devices will act in a way quite similar to an electric cell proper. Mr. Ruhmer showed, by some interesting experiments, the fluctuations in the intensity of a current traversing the selenium cell, as produced by variations in the luminous intensity. A glow lamp connected in series with a selenium cell was, for instance, shown to give a dark red light while the selenium was in the dark, while an intensely white glow was noted as soon as the cell was exposed to the action of light. The action of extremely rapid fluctuations in the luminous intensity was illustrated with the aid of a rotating disc, having circular rows of holes, through which a selenium cell was illuminated. The cell was connected to a battery and a loud-speaking telephone, which, with the alternating illumination and darkening of the cell, would yield a loud sound, heard throughout the hall. As regards the numerous practical applications of selenium, the selenium photometer, serving to measure the luminous intensities and the electric telephotographic apparatus designed by Professor Korn for the transmission of handwriting, pictures, and photographs, were discussed at some length. Selenium ignition devices, lighting automatically gas or electric lamps at nightfall and extinguishing them at daybreak, were presented to the assistants, and the application of selenium cells to wireless (optical) telephony was fully described in detail.

The Steam Turbine in Germany.

As a counterpart to the steam turbine trust formed by the Allgemeine Elektricitäts Ges. Berlin, with the General Electric Company, the Siemens-Schuckert-Werke some time ago entered a combine with some important firms, among which there is Friedrich Krupp, Essen, Germany, the North-German Lloyd, and the Vereinigte Maschinenfabrik Augsburg u. Maschinenbau-Ges, Nürnberg. The object of this combine is the exploitation of the Zoelly steam turbine, built by the Swiss firm of Escher Wyss and Co., Zürich, an improved type of which is just being brought out.

This is a multiple-step axial action turbine, where the steam is conveyed to the running wheels through guiding wheels, so as to have in the high-pressure step a partial and in the low-pressure step a total charge. The guiding wheels are fitted steamtight into the turbine casing, one running wheel being arranged between each two guiding wheels; the running wheels are mounted on a common shaft, traversing the whole length of the turbine. The running wheels are discs forged from the best class Siemens-Martin steel and are rigid with the nave. On the rim of the discs are mounted the turbine buckets, which have the form of relatively long rays, their cross section increasing at a regular ratio from outside inwards towards the axle of the wheel, thus maintaining constant the specific strain throughout the length of the bucket. The highest resistibility both with respect to the centrifugal force and steam pressure will thus be secured. The peculiar construction of the buckets will enable comparatively high-wheel diameters, and, accordingly, great peripheric speeds, to be adopted, thus allowing of a much smaller number of steps being used than with steam turbines of other systems. The regulation of the turbine is secured very efficiently in a way similar to that of the hydraulic turbine built by the company, namely, by means of an extremely sensitive spring governor, including a servomotor, the entering tension of the steam being altered according to the load.

A further feature is the fact that the turbine shaft is located outside on a base frame quite independently of the turbine casings, so as to avoid any action of the steam heat, or of the thermic expansion of the turbine casings on the bearing; the latter, moreover, are so arranged as to be readily accessible. The safety of working is warranted largely by the absence of any compensating pistons, the great clearances between the moving and stationary parts of the turbine, the simplicity and solidity of the running wheels, the small number of the latter, etc.

A turbine direct coupled to a rotary current generator, built by the Siemens-Schuckert-Werke, is being operated in the workshops of the company, giving an output of 600 h.p. Recent tests made on this turbine by Professor A. Stodola gave the following results :—

I.—Saturated Steam.	kilogrammes.
Running at no load without excitation, steam consumption per hour	295·4
Running at no load with excitation, steam consumption per hour	465·4
80·1 kilowatt output, steam consumption kilowatt hour	15·0
182·2 kilowatt output, steam consumption kilowatt hour	11·7
240·1 kilowatt output, steam consumption kilowatt hour	10·9
334·5 kilowatt output, steam consumption kilowatt hour	10·1
387·6 kilowatt output, steam consumption kilowatt hour	9·74
II.—Superheated Steam.	
390·4 kilowatt output, 220° temperature steam consumption per kilowatt hour ..	8·98
391·7 kilowatt output, 240° temperature steam consumption per kilowatt hour ..	8·63

MINING NOTES.

BY A. L.

Wanted—A Railway.

If there is one mining country in the world above all others that needs railway development it is Peru. Mr. F. J. Schafer, in the present issue, calls attention to vast tracts rich in agricultural and mining possibilities, and awaiting only to be linked up with civilisation. Several proposals have been discussed. Some are in favour of a railway running along the shores of the Pacific, but this is open to two objections. Firstly, it would leave the regions beyond the Andes very little better off, and, secondly, it would only be doing at considerable expense what can be done at present by maritime traffic. The exceptional difficulties connected with the Oroya line are well known to engineers, and its heroic features have given Peru a name for records in railway construction. Mr. Schafer proposes to open up the rich Huaylas Valley by continuing the present line from Chimbote along the course hewn out between rocky gorges by the River Santa. He will in this way be able to take advantage of pioneer work which was carried out by the late Mr. Meiggs before the outbreak of the Chilian War. Of the possibilities of Peru there can be no question; they are accredited by such men as Andrew Carnegie and Sir Martin Conway. Railway development appears to be the one thing needful, and Mr. Schafer's project should therefore meet with the hearty co-operation of everyone who is interested in Peru.

Professor Hele-Shaw in South Africa.

I have just been reading about the annual dinner of the Chemical Metallurgical and Mining Society of South Africa, and though its menu is of the past and its gustatory joys have departed, I catch an after flavour of the general good humour that prevailed as well as a glimpse of Professor Hele-Shaw in his new sphere. The Professor was called upon to propose the toast of the Society, and, judging by the report, he did it most worthily. It was only a few years ago he said that the members of what he believed was nicknamed "The Cyanide Society" were congratulating themselves on having fifty members. To-day the number was rapidly approaching one thousand. Their Journal was read and studied with the greatest interest all the world over, and why?—because it was a journal of research. As to the benefits of research, he remarked that fifteen years ago, so he was informed, 40 per cent. of gold was allowed to go to waste, and to-day it was considered quite wrong, and someone heard of it, if even 10 per cent. were allowed to go through. He read that their esteemed member, Mr. Hennen Jennings, said once that the recovery of even a grain of gold per ton—he believed it was on a mill of 200 stamps—represented something like £22,500 a year saving. Well, these were very important and practical results, and he had no wish to belittle them, but he did read with great satisfaction that there was another side of the work of their research—viz., the study of knowledge encouraged by contributions on questions such as ventilation, the prevention of accidents and preservation of life, so that the humblest worker in the mines was cared for in a way that some of their friends at home would scarcely realise.

On Research without Great Discovery.

Professor Hele-Shaw from this point was led to speak of the many who engage in research but fail to attain a great result or any great discovery. He was glad to see that their Society encouraged by the award of valuable prizes and gold medals the publication of researches—not always those which have been pecuniarily successful, but researches which contributed to the sum of human knowledge. There were many men who worked with a practical object in view, who never attained any discovery of their own. Probably one man at least who did not discover Röntgen rays knew more about the subject than the man who did discover it. There were many who had been on the verge of other discoveries whom they knew never reaped pecuniary benefit; therefore, he hoped they would encourage the reading of their Society's papers, which contributed to solid information and knowledge. He found the philosophy of Josh Billings true to life. He said: "A man spends half his life throwing stones at a mark, the next quarter he goes up to see if he has hit the mark, and the last quarter he finds that he has not hit it and dies." At any rate, they could encourage men to bring forward their knowledge, and there was one thing about their Society which he felt sure of, papers would always be vigorously discussed. There was a vigour about their discussions which would make any man hesitate to rush in recklessly to impart information or facts which had not been corroborated, and he looked forward to great results from the new institution which had commenced its work only a week or two ago, and felt sure that they would extend to his younger colleagues, for he was only there for a few months, at the commencement of this work—that they would extend to those young professors gathered together the same kindness and welcome that they had extended to him.

He thought the time had arrived when the Society should have a motto, and suggested "Our highest aim should be equal to our possibilities." Might he suggest that no nobler motto could be found for the Society. If it was too intelligible it might be put into Latin. (Laughter.)

Sir C. Le Neve Foster.

Sir Clement Le Neve Foster, who lived such a short time to enjoy his well-earned knighthood, has left something more than a name behind him. His career, which was sketched in the pages of this magazine as recently as December last, offers a splendid example to the young mining student who is seeking the arduous way that leads to success. His numerous articles, too, are legacies which have a high value among mining men. Only last year he completed an excellent guide to mining, and it was doubtless the remembrance of his own early experiences that made him ever an enthusiastic guide, philosopher, and friend to the mining student. He had a singularly lucid manner of expressing and arranging his ideas. For instance, at one of the last meetings he attended of the Institution of Mining and Metallurgy, he concluded his contribution to the debate on the equipment of laboratories for advanced teaching and research in the mineral industries by summing up his remarks as follows:—

"First, when a student had a limited amount of time at his disposal, he had better forego training in a research laboratory, if such training would encroach upon the time required for practice at actual mines and works.

Secondly, many mining and dressing problems could be decided by experiments on a small scale.

Thirdly, some full-sized machinery was desirable in the laboratory, but not too much."

If all speakers in technical debate reached this standard, there would be few complaints of time wasted

OUR TECHNICAL COLLEGES.

BY A TECHNICAL STUDENT.

The Glasgow and West of Scotland Technical College.

During the session just closed there have been two important changes in the teaching staff. At the beginning of the Session Professor A. MacLay, B.Sc., who was appointed in 1880, resigned the chair of Machine Design, and was succeeded by Mr. John H. A. McIntyre, of Allen Glens School, who takes the position of lecturer.

At the end of the Session Professor W. J. Rowden, B.Sc., A.R.S.M., resigned the chair of Applied Mechanics which he has held since 1876, and is succeeded by Mr. J. G. Longbottom, A.R.C.S., who has been lecturer on Mechanics for some years.

Professor Rowden has had a long and varied experience, and his withdrawal will be a great loss to the College. He is a man of great originality of thought, who in the early days of science teaching worked out for himself the methods which he has used with conspicuous success during his forty years' teaching. Mr. Rowden was one of the first Royal Exhibitioners under the Science and Art Department, and he commenced teaching Mechanics when there were no guides and no recognised system, and his influence had much to do with the shaping of the work of the Science and Art Department. His teaching has left its mark on the teaching methods of to-day, and many hundreds of students, not only in the West of Scotland, but elsewhere, look back to the time spent under his guidance with feelings of gratitude and pleasure, and many feel that what success in life they have attained they largely owe to him. There is hardly a place in the world where engineering industries are carried on by British workers that his past students are not to be found. He retired with the very best wishes for his future happiness alike from his colleagues and his students.

The new buildings for the College are making rapid progress, and sufficient has now been done to allow an idea to be formed of what will be the effect when the work is completed. The buildings will cover about two acres, of which about three-fourths are at present in course of erection, the remainder cannot be commenced until the old premises in George Street can be vacated, as these occupy the site which is to be covered by the new buildings.

The foundation-stone was laid by H.M. the King in May last; part of the building will be occupied in October; and it is expected that the whole of the part now being erected will be ready for occupation in April of next year, when the Chemical, Physical, and Metallurgical Departments, which are now housed in George-street, will be transferred.

Extensive as was the original plan, it has been found to be insufficient for the calls for space, and St. John's Parish Church, which adjoins the buildings, has been purchased for £13,000, and will be pulled down to enlarge the area of the site.*

The Municipal School of Technology at Manchester.

In the course of an article on Cylinder Condensation and Valve Heatage in Steam Engines, contributed to "Power," Professor S. T. Nicholson mentions that in the new laboratory of the Municipal School of Technology, Manchester, a 200 h.p. engine has been installed for the express purpose of studying the questions of the amount and character of the leakage of steam in the case of valves of various types. The engine is of the horizontal, compound side-by-side type, having cylinders 11½ in. and 20 in. diam., with 3 ft. stroke. It is provided with two cylinders of each size, either of which may be used as desired. One of the 20 in. cylinders has slide valves with Meyer expansion plates, and the other has Corliss valves and gear. Of the two 11½ in. cylinders, one was made by Gebrüder Sulzer, and fitted with their design of drop valves, and the other has Corliss valves and gear of the same type as for the 20 in. Corliss cylinder. Thus a comparative study may be made of the efficiency of different types of valves, *e.g.*, Sulzer *versus* Corliss, or Corliss *versus* slide valves, and of the effect of size-variation by experiments on the 11½ in. and 20 in. Corliss cylinders.

American Technical Education.

Apropos of the Commission of Enquiry into the Educational Systems of the United States, I note that Mr. Albert R. Ledoux, of New York, has summed up his conclusions as to the efficiency of the American Mining Engineer in the form of a paper contributed to the American Institute of Mining Engineers. In the course of this he says:—

"There is not a man of us who belittles technical education; not one who does not recognise the honoured names upon the roll of Alumni of our American schools of mines or of the schools of Paris or Freiberg; nor is there one who does not rejoice at the practical developments of the mining schools of our neighbour on the North. But those whose names we honour most have been the men who have supplemented their college training by a post-graduate course in Nature's laboratories. No, our American mining engineer is not simply a product of our American system of education, but is born of the necessity for original work and invention due to the demands of a new country unhampered by traditions. One of the great disadvantages of our brothers in older countries lies not simply in the fact that their courses of study are usually along well-established, and therefore inflexible lines, but that they are in contact with men who object to change in practice. Our American technical institutions are comparatively young, and therefore ready to adopt anything that seems to be an improvement upon established methods."

He further remarks that the American expert soon learns that time is money. This ability to "hustle" which is born of the soil and pervades the atmosphere, is another characteristic of the American mining engineer not acquired in any school. His argument, in brief, as stated to the British Educational Commission, is that the standing of the American mining engineer is due not exclusively to his initial education, but to the necessity for initiative born of environment, to the mechanical instincts of the race, and to the natural buoyancy and self-reliance of the American people.

* A view of the buildings, as they will appear when complete, will be found in "P. M. Monthly Illustrated Notes."

OPENINGS FOR TRADE ABROAD.

British India.

There is a good opening for tools of moderate price. The Hindoo workman does not want costly and highly finished implements.

Belgium.

The Foreign Office has received a copy of the notification issued by the Belgian Government, inviting tenders for new works on the port at Ostend, including the construction of a dry dock. Tenders, addressed to the "Directeur du Service Spécial de la Côte, 1, Square Stéphanie, Ostende," must be posted before July 24th. Plans may be obtained at the Enquiry Office, 15, Rue des Augustins, Brussels, at a cost of 5s.

An iron bridge is to be constructed over the Senne between the communes of Schaerbeck and Laeken; the estimated cost of the structure is about £2,566.

Tenders are invited for the construction of a line of railway from Carfontaine to Jamagne, at the estimated cost of £83,344. Tenders will be received at "La Bourse, Bruxelles," up to June 11th. A deposit of £3,600 is required to qualify any tender. Specifications, etc., may be obtained from the above address on payment of 3s. 7d.

Germany.

The Hamburg Senate proposes to arrange for the construction of a tunnel under the Elbe. The Clyde tunnel at Glasgow has been taken as a model for this plan; it is intended that the tunnel shall run from the St. Pauli landing-place on the north bank of the river to the Steinwarder bathing establishment on the southern bank. It is proposed that two tunnels of 4·8 metres internal diameter shall run beneath the river at the two points named, and passengers will be conveyed by means of a lift at each extremity of the tunnel. The lifts are to be built to convey 20, 80, and 100 persons respectively. The time of building is estimated at about from two to three years.

Portugal.

The plan for the construction of the first section of the railway from Pocinho to Miranda, namely, that comprised between the station of Pocinho and Moncorvo, a distance of 12,240 metres, has received the Royal approval, and the construction of this railway has been ordered to be proceeded with immediately.

Spain.

Tenders for an electric tramway from Ubeda to Santuario de la Yedra, in the Province of Jaén, will be adjudicated on June 20th next. Persons desiring to tender must present their offers in due form, with a document showing that the sum of £79 has been deposited as caution money. The adjudication will turn in the first instance on a reduction of the tariff for the conveyance of passengers and goods.

A concession has been granted for constructing and working an electric tramway in the Canary Islands from San Cristobal de la Laguna to Tacoronte. A concession has also been granted to the "Seville Tramways Company, Limited," for the construction and working of an electric tramway from Arecife de Capuchinos to San Fernando in Seville.

Tenders, which will be opened on June 11th, are required for the supply of 10,000 kilogrammes of forge iron for use in repairs on the vessels *Temerario* and *Vincente*.

Adjudication of tenders will take place before the Director-General of Public Works, Madrid, on July 6th for the construction and working of an electric tramway in Bilbao. The competition will turn, in the first place, on the reduction of the tariff fixed for the conveyance of passengers, etc.

There is an opening in Fernando-Po for corrugated iron buildings, bridges, rails, trollies, etc.

The construction and working of the following lines have been sanctioned: A metre gauge railway from Seville to the town of Pos Hermanas; a narrow and broad gauge railway from Veriña to the Port of Musel; a narrow gauge railway from Llerena (Badajos) to Linares (Juen).

Italy.

Extensive maritime improvements are to be carried out in the harbours of Spezia, Leghorn, Naples, Brindisi, Bari, Venice, and other Italian ports, for which purpose the Government has sanctioned the expenditure of £1,280,000.

Austria-Hungary.

The Hungarian Minister of Finance has introduced a Bill authorising the extension of the State Railways, the construction of new lines, and the execution of all other works of public utility, including Government buildings, fortifications, bridges, and harbour improvements. The works to be executed during the present year will absorb a sum of £3,167,000.

Russia.

There is an increasing demand for motor-cars.

Argentina.

The Argentine Government has allotted £10,000 for the purchase of boring machinery.

A contract has been approved for the construction of defence works at the northern basin of Buenos Ayres for the sum of £37,000.

Mexico.

The Mexican Government has entered into a contract with the Cananea Consolidated Copper Company, Limited, conceding to them the right of constructing and working four railway lines in the States of Sonora and Chihuahua.

The construction of railway lines in the State of Guanajuato from Jalpa to Leon and Salamanca has also been sanctioned.

NOTABLE BRITISH PAPERS.

A Monthly Review of the leading Papers read before the various Engineering and Technical Institutions of Great Britain.

A PAPER ON COAL-CUTTING MACHINES.

AT the Jubilee Meeting of the Society of Engineers an instructive paper was contributed by Mr. A. S. E. Ackermann on "British and American Coal-cutting Machines." The various forms of machines in use on both sides of the Atlantic were carefully described, the paper also including a section devoted to statistics and tables, etc., showing the influence of the use of these machines on accidental deaths in coal mines. He conclusively showed that the States of Pennsylvania, Illinois, West Virginia and Ohio, which cut large percentages of their coal by machines, had, on the average, a lower death rate per million tons of coal raised than those States which had a smaller output and cut a smaller percentage by machinery. The author, in his introduction, remarked that the history of coal-cutting machines is in some respects similar to that of many other excellent inventions, in so far that they were first invented in England, but did not attain commercial success in this country, largely owing to the want of public support. They were then taken up by the Americans; the designs were considerably altered, and machines of entirely new design were also made, and commercial success was achieved.

In 1891, which is the earliest year in which any official records of coal-cutting machines were kept, there were only 545 coal-cutting machines in use in America, but in 1902—only eleven years after—there were 5,418 machines. To complete the historical analogy, it may be added that now, years after the successful use of coal-cutting machines in America, we are beginning to use a few machines in England—there were, in fact, 483 machines in use in this country in 1902.

The first coal-cutting machine was patented by Michael Menzies, of Newcastle, in 1761, and in 1867 Mr. Howit, an Englishman, patented the machine which is the prototype of the pneumatic percussive machines. The early machines for any special purpose frequently imitate in their action the method of performing the same operation by hand. Thus we find the early coal-mining machines, of which several are preserved in the South Kensington Museum, had reciprocating picks, in imitation of the action of an ordinary miner's pick wielded by hand. Not only does the credit of inventing the first coal-cutting machine belong to an Englishman, but apparently the first designs of each of the well-known types of machines were invented also by Englishmen, for in 1861 Hemmingway patented in England a disc-cutter machine. Indeed, we might very well go back to Hedley's horizontal circular-saw machine of 1852, and consider his as the prototype of the disc machines. The first endless chain-cutter machine was patented in England by Peace in 1853, while the first in America was granted to Prosser in 1876. Again the first bar-cutter patented in England was invented by Johnston and Dixon in 1856, and the first in America, by F. M. Lechner, in 1878, although the latter differed essentially from the former.

BRITISH MACHINES.

The author's account of British machines was as follows:—

There are now practically only two types of coal cutters in use in England, namely, the longwall disc machine, and the longwall bar machine, although some longwall chain machines, and a few heading and percussive machines are also in use. The latter, however, differ from the percussive machine so largely used in America. The type used in England is fixed to a rigid vertical post, which takes the shock of the blow. The machine can be moved up and down this post, and can also be arranged to make a cut in a vertical plane or in a horizontal plane, the feed motion being derived from a quadrant and worm. As the cut gets deeper, lengthening pieces are put in between the piston-rod and bit, or cutting tool. This cutting tool is something like a crown wheel, whereas the cutting tool of the American percussive machines is fish-tail in form. The vertical post is fixed between the roof and floor either by a screw arrangement, or by a small hydraulic ram contained in the column. It is only a very strong roof which will stand the great thrust of the post as well as the reaction of the blows of the machine; but given such a roof, the machine is a very useful one.

The heading machine which is used in England, and to a slight extent in America, is an English one, designed by Reginald Stanley. This machine has one or two rotating shafts perpendicular to the coal-face to be cut. When there is only one shaft, it is coincident with the axis of the heading. On its distal end is fixed a sort of cross-head, which, however, is made to rotate instead of having a reciprocal motion. The cutters are arranged on this cross-head in one of two methods. In the first method, they are fixed across the cross-head so that the whole of the coal is bored out of the heading and turned into slack, which is automatically loaded on to a following tub by an Archimedean screw. In the second method there are only two cutters, but each is 2 ft. long, and fixed at right angles to, and at the end of the cross-head. When the shaft rotates, the cutters make an annular cut and a core of coal is left. This is removed by hand when the machine is stopped.

There is also a third form of this machine which has two parallel rotating shafts, each fitted with the arrangement described, and geared so that the cross-heads are at right angles to, and thus clear, each other. The cutter shafts in each case are driven by a pair of cylinders using compressed air.

Of the disc-cutter machines, the first to attain any commercial success was that patented by John Gillott and Peter Copley in 1868. Gillott and Copley machines are still at work, and have been copied by several later makers.

The general design of a disc machine consists of a rectangular steel frame mounted on four small flanged wheels for running on a pair of rails. On this frame are mounted a pair of cylinders, either side by side, as in the Gillott and Copley machine, or *vis-à-vis*, as in Garforth's "Diamond" machine. By means of a

crank shaft and intermediate shaft carrying a spur-wheel the cutter disc is driven. The cutter disc, or wheel, is about 5 ft. in diameter, and the cutters are fixed into the circumference. Just inside the rim of the wheel is a broad circular rack, the teeth running radially. The disc is supported by a broad plate bracket, which is fixed to one side of the rectangular frame. The spur wheel on the intermediate shaft gears with the circular rack of the disc, and thus drives the latter at about 15 revolutions per minute, though some are driven as fast as 50 revolutions per minute. The machine undercuts to a depth of 5 ft., and is drawn along the face of the coal by means of a steel rope. One end of the rope is attached to the frame of the machine and is carried along the coal face, at the far end of which is a fixed pulley. The rope is bent round the pulley and the end made fast to a winding drum on the machine. This drum is driven by a ratchet gear, and thus the machine hauls itself along the face.

Some of the machines, such as the "Diamond," are arranged to cut in either direction, and some are fitted with electric motors instead of pneumatic engines. It takes from 20 to 30 minutes to change all the cutters, and three and four changes are usually necessary during each 8 hours' shift. The cutters, or bits, of the disc and chain machines have chisel edges, but those of the bar machine have sharp points set at an angle to the shank. The disc machines cannot make a sumping cut, hence at starting a place for them has to be holed by hand.

There are two types of rotary bar machines, but only one of these, the Hurd or Goolden, is now used. These consist of a strong tapered bar about 7 ft. long, making a cut 9 in. high at the face and 4 in. at the back. Into this bar are fixed a number of sharp pointed cutters. The sockets for the cutters are arranged in the form of a helix so as to cause most of the cuttings to be brought out. The bar can be swung round till it is parallel to the coal face, or at right angles to it. It can also be slewed slightly in a vertical plane, to go over or under a sulphur ball or other obstruction. The machine hauls itself along the coal face by means of a wire rope, as described in the case of the disc machines. To start a cut the cutter-bar points straight back, the machine is then started, and the bar gradually rotated into the coal until the bar is at right angles to the coal face; the bar revolves at about 400 revolutions per minute. Both types of bar machine are electrically driven.

In the other type of bar machine, which is now obsolete, the bar was the same diameter throughout its whole length, and it was engaged broadside on with the coal face. Hence this machine could not be drawn continuously along a face; a sumping cut had to be made, then the machine was withdrawn, fitted sideways, and another sumping cut made. The rotating bar was carried on the end of a sliding frame, which was driven forwards from the main frame.

As to the important question of cost, English experience, as recently determined by the Committee of the North of England Institute of Mining and Mechanical Engineers, is that after everything has been allowed for, there is a net saving of 6d. per ton raised in favour of the machines, the average cost of labour per ton of machine-cut coal being 2s. 3½d. This is not the only point however. The average increase of output per man employed has amounted to 65 per cent. Another advantage of machines is that they produce on the average 12½ per cent. more round coal, *i.e.*, where the percentage of lump coal got by hand is 60 per cent., in the case of machine-cut coal it is 72½ per cent.

The cost of a complete plant for say ten disc machines averages £1,000 per machine, whether electricity or compressed air be used, though the latter is slightly the cheaper. The individual electric machines, however, cost about £400 each; while the pneumatic machines cost about £250 each.

THE DESIGN OF A DRY DOCK.

At a well attended meeting of the Junior Institution of Engineers, held at the Westminster Palace Hotel, a paper on "The Design of a Dry Dock" was read by Mr. A. W. Young, of the Admiralty Works Department (member). The Chairman, Mr. S. Cutler, Junr., M.I.Mech.E., presided.

The author dealt with the subject chiefly from the designer's point of view, and further restricted his observations to questions affecting the stability of the structure more than to elements relating to the outline either in plan or profile. The type of dock considered was of the class usually constructed by the Admiralty for the docking of His Majesty's ships, although the diagrams shown did not represent any particular dock.

It was pointed out how serious the questions of length, width of entrance, and depth over sill for dry docks had become, and to illustrate the rapid growth of ships in beam and draught during the last sixty years, a diagram was exhibited giving the profiles of ships of sixty years ago and the development of their lines up to the present time. Allowance for future extensions of beam and draught in ships was touched upon, the author stating that this was quite a matter for the naval architect to decide. No matter how long or how broad the docks were made, it really seemed that directly they were completed, ships were designed that filled them, and so gave cause for reflection as to whether sufficient margin had been allowed, although seeming ample at the time the lines for the docks had been decided on.

After these general remarks, the question of the profile was touched upon under (*a*) convenience in docking ships; (*b*) space for facilities in carrying out repairs; (*c*) restriction of cubic contents as far as possible.

Under section (*a*) the spacing of the altars and its bearing on the shoring of the ships was dealt with; under (*b*) the value of the head-room beneath the ship, owing to the very flat bottom of the present-day ships, which head-room affected the level of the floor of the dock in its relation to the level of the entrance sill; and under (*c*) the amount of pumping to be done in emptying the dock.

In dealing with the question of stability, the author urged the advisability of making borings to first ascertain the general lie of the various strata, and also of sinking trial pits at intervals for more detailed particulars. Much inconvenience would be avoided by having reliable information as to standing water level, and a knowledge of the nature and properties of the ground in which works of magnitude were constructed. The stresses in the walls and floor were fully treated, and their amounts at various points given. Referring to the results and conclusions arrived at, he suggested that instead of a beam, the dock floor more nearly approached the form of an arch, but he would prefer to describe it as neither the one nor the other, but rather as "one side of a concrete structure subject to pressures in vertical and horizontal directions simultaneously." To arrive at the section best suited to resist the stresses induced must be by trial and error. If, however, the engineer did

not wish to have such thick floors, the system of putting pipes through the floor to relieve the hydrostatic pressure could be adopted, providing the foundations were not of such a character as to be injuriously affected by the water passing through, but an objection to this was the pumping rendered necessary during the time the docks were in use, which, if extensive, would be a heavy annual charge; it therefore was a question as to whether the first cost for a thicker floor would not be more economical than paying for the increased pumping.

The steps and timber-slides, the drainage-culverts, the pumps, the capstans, and bollards, etc., were referred to, and also the methods adopted in construction and the materials employed.

In considering the dock entrance, the parallel-sided caisson by means of which it was closed was fully described and illustrated by diagrams. The distribution of the loads on the caisson groove from the keel, and the process for finding the centre of gravity and centre of buoyancy were entered into, and remarks made as to the relation those centres bore to each other. The working of the caisson in opening and closing the dock was also considered.

The author stated in conclusion that a dock designed as described would cost :—

For the dock	£225,000
Which is equivalent to 22s. per yard cube, measured externally, or 39s. per yard cube of internal capacity, or again £321 10s. per ft. cube of dock	
Pump wells, culverts, and penstock shafts	25,000
Engine and boiler house	18,000
Penstocks	6,000
Caisson at £2 4s. 6d. per ft. super of entrance	8,000
	£282,000

The paper was illustrated by a large number of excellent diagrams, and in the discussion which ensued Messrs. Adam Hunter, F. W. Hodgkinson, A. R. Gibbs, R. G. Keevil, L. H. Rugg, J. W. Nisbet, C. W. Pettit, A. W. Metcalfe, G. H. Hughes and G. W. Brake took part.

A vote of thanks having been accorded the author, the meeting closed with the announcement of the visit on May 12th to the Great Northern, Piccadilly and Brompton Railway Works.

THE WORLD'S IRON AND STEEL INDUSTRIES.

BEFORE the Society of Arts Mr. William Pollard Digby, A.M.I.Mech.E., A.M.I.E.E., recently read an important paper, entitled "Some Statistics of the World's Iron and Steel Industries." The writer presented his investigations from :—

(1) The iron founder's standpoint in England and Germany in regard to the respective supplies of iron ore in the two countries, and their productions of pig iron as compared with the United States.

(2) The statistical standpoint showing the extent of the external import and export trade of the United Kingdom relative to that of the external trade of other countries; and

(3) The margin of profit of the iron industries reckoned on the external trade alone of the leading iron-producing countries.

A detailed history of imports and exports is presented for thirty-five years, and quinquennial averages and percentages are given. A balance is then struck between imports and exports, a surplus of the latter being treated as "profit" or currency margin available for the purchase of other commodities.

Pointing out the difficulties of obtaining a complete survey of so vast an undertaking as the British iron trade, the author remarks that :—

While it is possible to define the value, say, of steel rails, respectively, imported and exported from the United Kingdom, we do not know the total production or the value of steel rails used in any year by the different railway companies and tramway undertakings within the kingdom. Again, it is possible to give the value in any year of the locomotives sent to foreign countries and to our own Colonies, and it is not difficult to enumerate the sporadic dumpings of locomotives into England on those occasions when lack of foresight has allowed the number of engines under construction to fall below immediate requirements, so that occasional purchases from America have resulted. We can, in this latter case, go a step further and give the number of locomotives included in the rolling stock for any one year. But we cannot give the amount of the expenditure in any year on new locomotives either for our railways or for the rough lines laid by contractors for their dock, or reservoir, or railway, constructional work.

Similarly, if we regard shipping, while returns have of recent years been published giving the values of our sales of new ships built for foreign countries, we have no return of the value of the yearly additions to our mercantile marine, or of the value of the plates, rivets, or stern-frames which, forming the raw material for the shipyard, are nevertheless the finished product of the steel merchant. We are also without returns as to the value of the iron and steel supplied to the ship's engine builders wherein "the purring dynamos," the towering five-crank reciprocating engines, the compact turbines, the belauded Scotch and belittled Belleville boilers, find their raw material.

While we cannot, with any certainty, state the extent to which these imports have, by ensuring cheap production, assisted (in the case of Great Britain) in the growth of our steadily expanding export trade, we can prepare balance-sheets as to the state of affairs in each country in each year. To the credit side all exports are reckoned which are embraced in the export returns of the countries under consideration, while to the debit are placed the ascertained imports. An excess of exports is reckoned as profit. That is to say, the margin by which the exports of the products of any particular industry exceeds the imports in that industry represents the profit or balance by which the excess margin is available for exchange against imports of food or luxuries. Similarly, an excess of imports, so far as that particular branch of industry goes which necessitates the exports of other manufactures or food stuffs is treated as a loss—a loss not of an Australasian Colonial Premier's "golden

sovereigns" but of produce or service rendered which another department of a country's commerce or industry makes good.

The British diminution of profit occasioned by exhaustions of ore and increase of imports deals only with an apparent currency loss so far as the entire country is concerned. In the case of the United Kingdom it is possible to compute the extent to which the fall in profit, as measured in currency, has been neutralised by the fall in prices.

Assuming that the profit margins already computed had in each case been exchanged against food, it would be possible to calculate the relative value of the profit measured in food. This relative co-efficient of food profit becomes a factor of the greatest value, for by it alone can be ascertained the relative position of the country as a whole with regard to the manner in which its surplus manufactures help to feed its population.

The writer ascertains this relative co-efficient of food profit for any quinquennium by dividing the proportionate profit value of any quinquennium by the average value of Mr. Sauerbeck's index values for food for that quinquennium.

TABLE III.—PIG IRON.

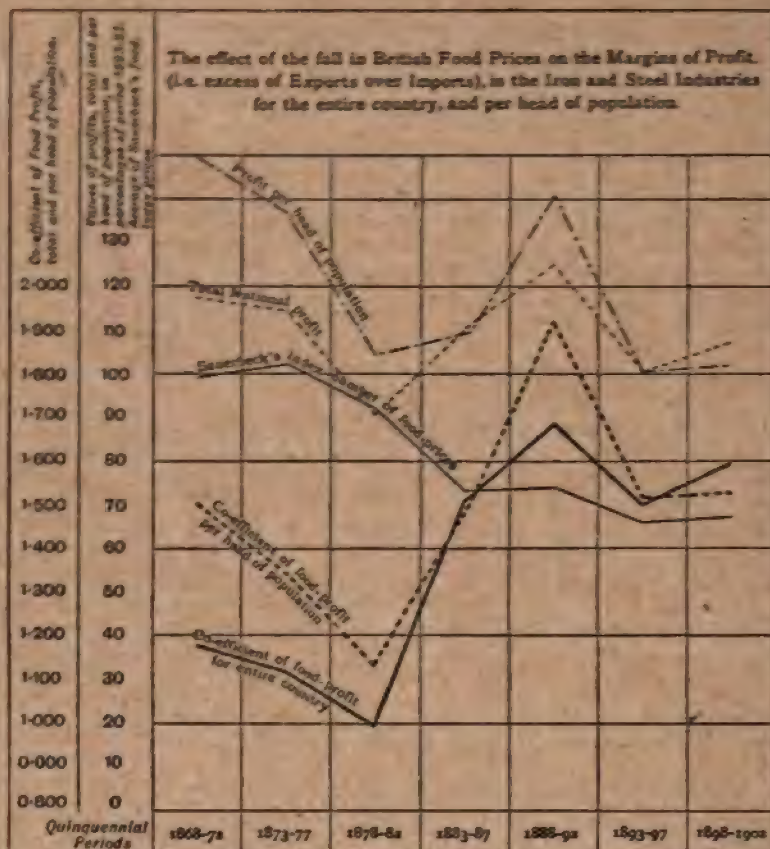
Production, Consumption, with Balance Imported or Exported. Annual Averages. Tons 000's omitted.

Balance excess of Production indicated +, excess Consumption indicated −.

Quinquennial Periods.	1873-77.	1878-82.	1883-87.	1888-92.	1893-97.	1898-1902.
United Kingdom—						
Production	6,416	7,265	7,665	7,668	7,913	8,720
Consumption	5,536	6,007	6,501	6,727	7,029	7,744
Balance	+880	+1,258	+1,161	+941	+984	+976
Germany—						
Production	1,991	2,680	3,622	4,620	5,417	8,041
Consumption	2,319	2,656	3,586	4,724	5,905	8,287*
Balance	−428	+24	+36	−104	−488	−63†
United States—						
Production	2,184	3,529	4,968	8,147	8,261	14,176
Consumption	2,445	3,961	5,249	7,834	7,839	13,643*
Balance	−261	−332	−281	+313	+422	+122†
Proportionate Values, putting the consumption of each country in 1893-97 as equal to 100.						
United Kingdom—						
Production	91	103	109	109	113	124
Consumption	79	85	93	97	100	111
Balance	+12	+18	+16	+13	+13	+13
Germany—						
Production	37	46	61	78	92	136
Consumption	41	46	61	80	100	140*
Balance	−4	..	..	−2	−8	−1†
United States—						
Production	28	45	63	104	105	182
Consumption	31	50	67	100	100	174*
Balance	−3	−5	−4	+4	+5	+2†
Proportionate Values for Germany and the United States, putting the consumption of the United Kingdom 1893-97 as equivalent to 100.						
Germany—						
Production	28	38	51	66	77	114
Consumption	33	38	51	67	82	118
Balance	−5	—	—	−1	−5	−1
United States—						
Production	31	50	71	116	117	202
Consumption	35	56	75	111	111	194*
Balance	−4	−6	−5	+5	+6	+2†

* Four years only. † Balance reckoned on first four years only.

DIAGRAM 5.



This gives the following table:—

UNITED KINGDOM.

Quinquennial period.	Proportionate value of profit in quinquennium (the 1893-97 period being reckoned as equal to 100).	Average of the Sauerbeck food index price.	"Co-efficient of food profit" value expressed in ratio of food obtainable.
	a	b	$\frac{a}{b}$
1868–72	117	99	1·177
1873–77	114	102	1·117
1878–82	91	92	0·990
1883–87	110	73	1·507
1888–92	125	74	1·689
1893–97	100	66	1·501
1897–1902	107	67	1·506

These figures show that, taking the nation as a whole, the maximum of profit, when allowance is made for food value, was not in the early seventies, the era which has been so often cited as that of the zenith of Free Trade prosperity, but between 1888 and 1892. Above all should it be remembered that the quinquennium just ended shows, with one exception, the highest co-efficient of food profit. Of course, the criticism may be advanced that while this co-efficient of food profit has advanced, the population of the country has advanced at an even greater rate.

But, so far as comparisons of widely separated periods are concerned, mere currency profits, expressed in monetary tokens of exchange, are not comparisons which truly represent the state of affairs. Instead, we have to fall back on the factor, which the author calls the "co-efficient of food profit," and which he has calculated for the United Kingdom as a whole.

Expressed, therefore, per head of population we have the following table:—

UNITED KINGDOM.

Quinquennial period.	Proportionate value of profit per head of population in quinquennium (the 1893-97 period being reckoned as equal to 100).	Average of the Sauerbeck food index price.	"Co-efficient of food profit" per head of population, or profit value expressed in ratio of food obtainable.
	a	b	$\frac{a}{b}$
1868–72	149	99	1·505
1873–77	137	102	1·343
1878–82	104	92	1·130
1883–87	109	73	1·493
1888–92	141	74	1·905
1893–97	100	66	1·515
1898–1902	102	67	1·522

This table and the table showing the profit for the entire country are plotted together in diagram 5. The currency profits per head of population and for the entire country are expressed in percentages of the average for the 1893-97 quinquennium, and the Sauerbeck index price for food is also expressed in the average percentage for each quinquennium, the average in the eleven years ending 1878 being taken as equal o 100. The national and individual co-efficients of food profit are shown on a somewhat distorted scale (zero forming the base line on the percentage scale, and 0·800 on the co-efficient of food profit scale) in order to emphasise the fact that despite falls in profit measured in currency, the profit, both national and individual, measured in the purchasing power of that currency profit computed in food, has risen in a marked degree, as compared with the second and third quinquenniums, but has fallen as compared with the fifth quinquennium, the period in which, measured either by exports or gross profit, or profit, or profit per head of population, or co-efficient of food profit, the state of the external trade of the United Kingdom was the most flourishing.

Had it not been for the writer's earnest desire to discuss the facts wholly dispassionately, the temptation to ignore these imports, inasmuch as they are the return on British capital invested abroad, would have led him to substitute other tables than those presented concerning the various possible computations of profit. Had it not been for a desire to present facts without partiality or bias, the writer, looking from the point of view of one school, would have stopped short of showing how largely the fall in currency profit was neutralised by the fall in food prices, or looking from the point of view of the other school, he might in a pæan that all was well have latterly included the value of shipping built for foreign owners, a factor of £10,000,000 sterling.

Any person can prate of exports and imports, but who can speak even in regard to iron, of the employment given to thousands of artisans making looms for Lancashire, locomotives and rails for our railways, dynamos and arc lamps for our street lighting, steel girders and angle iron for our large buildings?

"Among the blind, the one-eyed is king." What shall we say of John Bull, who is not even equipped with half his powers of vision when considering his own entire commerce. External commerce is clearly displayed in export and import returns. Internal commerce is practically shut off from his vision. Its fruits, so far as percentage of pauperism, of savings-bank returns, are concerned, can be gauged any day. But the full extent of the effects of "dumping" can only be truly known when manufacturers will consent to a dissection of the statistics, not only of the trade of manufacturer A whose finished article is threatened by foreign competition, but also by a dissection of the trade of manufacturer B whose raw material is often the finished product of manufacturer A.

REPLY.

A discussion followed the paper, and in the course of his reply the author remarked that so long as our computations were based solely on exports and imports, our conclusions being only the product of two dimensions would naturally be superficial. Until we had the third, the total value of our commerce and the relation of our export and import trade to it would remain unknown, and would be the occasion of dragging up many scores of bogies—bogies perhaps which might be mere clouds on the horizon, which the rising sun of a cycle of prosperity would dispel. Until we had complete returns he feared that so far as judging our national prosperity was concerned, the Board of Trade statistics of import and export trades alone would only lead to the announcement of many false hypotheses.

COMING EVENTS.

June.

2nd.—The Institution of Mining Engineers: General Meeting.—Birmingham University Engineering Society: Annual Meeting.

3rd.—Institution of Mining Engineers: General Meeting continued.

4th. — Birmingham Association of Mechanical Engineers: Half-yearly Meeting and Social.—Institutions of Mining Engineers: General Meeting concluded.

6th.—Society of Engineers meet at 7.30 p.m.—South Staffordshire and East Worcestershire Institute of Mining Engineers meet at the Birmingham University.

9th.—Institution of Electrical Engineers: Annual Meeting.—Ipswich Engineering Society: Visit Messrs. Ransomes and Rapier's, Ltd., Waterside Works, Ipswich.

11th. — Birmingham Association of Mechanical Engineers: Annual Pic-nic.—North of England Institute of Mining and Mechanical Engineers: Meeting at Newcastle-on-Tyne, 2 p.m.

16th.—Institution of Mining and Metallurgy meet at 8 p.m.

18th.—Ipswich Engineering Society: Visit the Electric Tramway Station, Lowestoft.

29th.—Society of Arts: Annual Meeting.

30th.—Conversazione at the Society of Arts.

AUTOMOBILE NOTES.

By J. W

Proposed Institute of Automobile Engineers.

The proposal to form an Institute of Automobile Engineers speaks eloquently of the progress of the industry during the last few years. It is stated that ninety per cent. of the engineers who have been circularised are in favour of the scheme, and that a meeting will shortly be held to give it practical shape.

The Parade of Trade Motor Vehicles.

There were eighty-two vehicles represented in the Parade of Motor Vehicles held by the Automobile Club on the Victoria Embankment, London. These included sixty-nine steam vehicles, twelve petrol, and one electric vehicle. Ten prizes fell to vehicles made by the Thornycroft Steam Wagon Company, and among the makers of the other successful vehicles, the Lancashire Steam Motor Company and the Straker Steam Wagon Company were prominent. The prize vehicles also included a Wallis Tractor and Trailer, a Foden Tractor and Trailer, a Fisher Petrol Electric Van, a Milnes Daimler 'Bus and a Milnes Delivery Van, a vehicle by Clarkson, Ltd., and a White Steam Van.

The Calais-Dover Motor-Boat Race.

The final arrangements for the above race are now to hand. The race will be held on Monday, August 8th, from Calais to Dover, a distance of 22 knots, starting at 10 o'clock in the morning, and will be open to boats of all nationalities, of any size, and of any system of motive power. The race will be held under the Rules of the Automobile Club of France, and at the same time a race will be held for the Recope Cup for boats using ordinary petroleum, and for the Quinnones de Leon Cup for boats using denaturised alcohol. Under the regulations of the French Club boats below 8 metres must carry three life-buoys, and boats over 8 metres must carry four, every person taking part in a race must wear a life-belt, every boat must be unsinkable; every boat up to 12 metres must carry an anchor weighing 40 kilos., with a length of chain—40 metres; and above 40 metres the anchor must weigh 60 kilos, with 60 metres of chain. Side-lights, and a chart and compass must also be carried.

The Gordon-Bennett Eliminating Trials.

Douglas, Isle of Man, presented a most delightful venue for the Gordon-Bennett British Eliminating Trials. The official selection of the competitors who are to represent Great Britain stands as follows:—

S. F. Edge (Napier)—80 h.p.
S. Girling (Wolseley)—72 h.p.
C. Jarrott (Wolseley)—96 h.p.

Reserve: 1st, Hargreaves (Napier); 2nd, Stocks (Napier). The sensational accident to Earp's car has cost him the second place in the team. The decision of the Committee in his case has caused some discussion, and Mr. S. F. Edge has addressed a letter of protest to the Secretary of the Automobile Club, in which he says:—

"The trials were, I understood, held for the purpose of finding out the three best drivers and cars in combination to represent England in the Gordon-Bennett Race, and the finding of the Committee is that a Napier car, No. 9, driven by myself, is the best combination, and No. 6, driven by Mr. Clifford Earp, second best. This being the case, I fail utterly to see how any subsequent question affects the point at issue, providing Mr. Earp and his car are able to race at Homburg on June 17th, and until the Committee have satisfied themselves that he will be unable to do this my contention is that they are entitled to be second in the British team.

"Mr. Earp's car will be on the road again in perfect condition in a few days, and he himself ready to drive it.

"There is no doubt that your Committee are now aware that the accident to him and his car is comparatively slight.

"I trust that your Committee will give the most serious consideration to my protest, as Great Britain will have quite hard enough battle to fight without its second best competitor being eliminated through what appears to be a panic decision, which was come to a very short time after Mr. Earp's accident, when the most incorrect reports in regard to his accident were current, and I contend that if it is the intention of the Races Committee that the proved best British cars should represent Britain, then Mr. Earp must be included, as he is entitled to by his performance, as the Committee themselves admit."

In the meantime the German authorities are pushing forward their preparations for the great race, and by the wish of the Kaiser, the people of Homburg and its neighbourhood will observe June 17th as a general holiday.

Reliability Trial for Motor-Boats.

From the Technical Secretary of the Automobile Club I have received a copy of the Rules which have been formulated by the Club for the proposed reliability trial for motor-boats fitted with internal combustion engines. This being the first trial of the kind which has been held, it is hoped that important results may be obtained which will lead to the largely increased adoption of this form of engine for life-boats, tugs, and similar contrivances. The trials will be held on Southampton Water and will extend over two days, viz.: July 26th and 27th, the daily run being ten hours.

There will be five classes:—

1. Yachts' dinghies (clench built) not exceeding 15 ft. over all.
2. Yachts' launches (clench or carvel) not exceeding 20 ft. over all.
3. Yachts' launches (clench or carvel) not exceeding 25 ft. over all.
4. Yachts' launches (clench or carvel) not exceeding 30 ft. over all.
5. Launches of over 30 ft. in length over all.

Gold and silver medals will be awarded to the first and second boats in each class, provided that recommendations are made by the judges to the effect that the boats are worthy to receive them. Certificates of performance, showing speed, distance run, number of stops, and consumption, will also be given to all these boats that complete the two days' run. A special prize, presented by Mr. Campbell Muir, will be awarded to the boat using ordinary petroleum, kerosine or burning oil which scores the highest number of marks.

BOOKS OF THE MONTH.

"THE INDICATOR HANDBOOK."

A Practical Manual for Engineers. By Charles N. Pickworth. Part I. The Indicator: Its Construction and Application. Second Edition. Emmott and Co., Ltd. (London and Manchester). Whittaker and Co. (London). D. Van Nostrand Co. (New York). 3s. net.

Mr. Pickworth's excellent handbook on the modern indicator has already reached a second edition, and the author has now taken the opportunity of including descriptions of various types of external spring indicators, and of Messrs. Elliott Brothers' Differential Indicator Spring. The work has a valuable chapter on the use and care of the indicator.

"LA NOUVELLE USINE D'INCINÉRATION DES IMMONDICES DE LA VILLE DE BRUXELLES."

By M. J. Leurs.

This extract from the annals of the public works of Belgium for August, 1903, has been reprinted. The brochure contains a description of the new "Horsfall" destructor erected at Brussels, together with some particulars of the reasons for which this plant was adopted in preference to any other, and a description of the auxiliary equipment which has been laid down by the city authorities. As a record of one of the most notable destructor plants in the world, this pamphlet should be obtained by all who are interested in the subject. It is fully illustrated with diagrams.

"THE PRINCIPLES OF MECHANISM."

Being a Short Treatise on the Kinematics and Dynamics of Machines. By Herbert A. Garratt, A.M.Inst. C.E. Edwin Arnold. 3s. 6d. net.

A useful work for students of applied mechanics. It is one of Arnold's Science Series, and consists of two parts, as under: Part I.—Kinematics of Machines, the scope of which includes all matters connected with the conversion and transmission of motion, without taking into consideration the masses moved or the forces exerted. Part II.—Dynamics of Machines. This subject, says the author in his preliminary note, includes all matters connected with the conversion and transmission of energy, but attention is here confined to mechanical motions, including some of the simpler aspects of hydrodynamics.

"THE RAILWAY YEAR-BOOK FOR 1904."

Compiled and edited by G. A. Sekon. Published at the Office of the "Railway Magazine" by the Railway Publishing Company, Ltd. 2s. 6d. net.

Handy year-books seem invariably to increase until they are handy no longer, but this does not as yet apply to the "Railway Year Book for 1904," though a quantity of information has been added to this excellent publication on the subject of colonial railways, while the historical sketches of the various British railways—a leading feature of the "Year Book"—have been brought up to date. Official appointments are notified down to March 1st, and a vast quantity of useful information has been brought together rendering the "Railway Year Book" indispensable for the reference library.

"FRICTION AND ITS REDUCTION."

By G. U. Wheeler. Whittaker and Co. 3s. net.

The author has summarised much valuable experience on the subject of friction and lubricants within the covers of this small book, and he has thought well to include prices of the various oils, balls, and ball-bearings. The following summary of contents will sufficiently indicate the scope of the work, which is a reprint of articles contributed to a technical journal subject to re-arrangement and the addition of further matter. Introductory—Friction—Experiments of Friction—Oils and Lubricants—Properties of Oils and Testing Same—Testing Machines—Comparative Value of Lubricants—Distribution of Lubricants—Ball Bearings—Ball Bearings, Actual Practice—Forced Lubrication. The work has 62 illustrations, and forms one of Whittaker's Library of Arts, Sciences, and Industries.

"MACHINE DESIGN."

Part I. Fastenings. By William Ledyard Cathcart. D. Van Nostrand Co. (New York). E. and F. N. Spon, Ltd. 12s. 6d. net.

Practical from beginning to end and replete with diagrams and tables, this work presents in compact form for the use of the student and designer the latest data of the American shops. Commencing with Shrinkage and Pressure Joints, the author deals successively with General Formulæ; Proportions of the Joint; Metals; Forcing Pressures; Shrinkage Temperatures; Shrinkage *versus* Pressure fits; Stationary engines, data from practice; Marine engines, data from practice; Railway work, data from practice; Shrinkage in Gun Construction. The four subsequent chapters are concerned with Screw Fastenings, Riveted Joints, Theory and Formulæ, Tests and Data from Practice, Keyed Joints, and Pin Joints.

"STEAM-BOILERS: THEIR THEORY AND DESIGN."

By H. de B. Parsons, B.S., M.E. Longmans, Green, and Co. 10s. 6d. net.

Based upon a series of lectures delivered in New York, this work presents a useful survey of modern boilers with numerous examples and illustrations of the best-known types. The work is arranged as follows: Physical Properties—Combustion—Fuels—Furnace Temperature and Efficiency of Boiler—Boilers and Steam Generators—Chimney Draft—Materials—Boiler Details—Boiler Fittings—Mechanical Stokers—Artificial Draft—Incrustation—Corrosion, General Wear and Tear, Explosions—Chimney Design—Smoke Prevention—Testing, Boiler Coverings, Care of Boilers—Superheated Steam. Some very important hints are included on the care of boilers, and, as will be seen from the above synopsis, the author covers a wide range.

"MODEL ENGINE CONSTRUCTION."

With practical instructions to artificers and amateurs. By John Alexander, A.I.E.E., containing numerous illustrations and twenty-one working drawings from original drawings by the author, and redrawn by C. E. Jones. Second Edition, revised. Whittaker and Co. 6s. net.

The junior engineer making his first model will find here a store of information. He is first told how to

select his tools, and is then shown how to work up the separate engine parts from their castings. Further progress in company with Mr. Alexander will enable him to fit his horizontal engine together, and test it under steam. From this point of view he is in a position to give attention to other types of engines and a model railway will probably be undertaken if he is prepared to see the matter through. The plans are numerous and excellent, and we suggest that few volumes could prove more acceptable to the young mechanical engineer.

"A TEXT-BOOK OF ORE AND STONE-MINING."

By Sir Clement Le Neve Foster, B.A., D.Sc., F.R.S., A.R.S.M. Fifth edition. With frontispiece and over 700 illustrations. Charles Griffin and Co., Ltd. 34s.

The fifth edition of this valuable work has 764 pages, into which more than 700 illustrations have been introduced. It is impossible to turn over the pages of such works as these without realising the enormous comparative advantages of the modern student. The stream of publications on mining is, as the author remarked, so great that few can keep pace with it. This, we suggest, has its advantages, as well as its disadvantages, for it admits of a far wider selection, and with standard works available like "A Text-Book of Ore and Stone Mining," the embryo miner has, at any rate, an excellent ground-work upon which to build up his selective faculty.

"PRACTICAL COAL-MINING."

A Manual for Managers, Under-Managers, Colliery Engineers, and Others. Charles Griffin and Co., Ltd. 12s. 6d. net.

This work, from the pen of a practical colliery manager, has now reached its third edition, which has been carefully revised. It is illustrated by 520 figures, and deals in a practical manner with numerous problems arising in colliery work. The work is intended to fill the gap between the small elementary text-book and the large and comparatively costly work of reference, but it is in itself a valuable work o reference, and offers a mine of information to the young colliery manager. The following is a synopsis of contents: The Sources and Nature of Coal—The Search for Coal—Sinking—Explosives — Mechanical Wedges, Rock Drills, and Coal-Cutting Machines—Transmission of Power—Modes of Working—Timbering Roadways—Winding Coal—Haulage—Pumping—Ventilation—Safety Lamps—Surface Arrangements, Coal Cleaning, etc.—Surveying, Levelling, and Plans.

"REFUSE DISPOSAL AND POWER PRODUCTION."

By W. Francis Goodrich. With 98 illustrations. Archibald Constable and Co., Ltd. 16s. net.

The author is essentially an authority on destructors, and in the present volume he tells us exactly what progress has been made all the world over in the destruction of refuse by fire. We hope that in these days few people need to be convinced of the desirability of destructors from a sanitary point of view, but the destructor as a power producer is another matter, and, doubtless, there are many town councillors and others who will eagerly turn to Mr. Goodrich's book for information on this subject which they have failed to get elsewhere. Special attention has been given to modern developments in power production and utilisation. Mr. Goodrich addresses his closing remarks to those who have to make the choice of a destructor. He submits that the best modern destructors are highly satisfactory, that they may be erected in the most central positions without fear of nuisance, that they fulfil their primary object perfectly, and, lastly, that a very useful amount of power can be produced. The work is freely illustrated. It should be read by all who take an interest in this highly important question.

"A TEXT-BOOK OF COAL-MINING."

For the Use of Colliery Managers and Others. By Herbert W. Hughes. Fifth edition, thoroughly revised, enlarged, and in part re-written. With four Plates and 690 Figures in the Text. Charles Griffin and Co., Ltd. 24s. net.

The fifth edition of Mr. Hughes's well-known work owes its increased bulk chiefly to the timely inclusion of paragraphs on the use of compound and electrical winding engines, and the application of central condensation stations. The volume has now no less than 690 figures, covering every phase of the industry, not to mention some really admirable plates, one of which shows the Neumühl Colliery, Germany, as recently illustrated in PAGE'S MAGAZINE. As the writer points out, the mining engineer of the future will have to deal with commercial and technical problems that will tax his resources to the utmost. We question whether any student could better equip himself for the struggle than by a systematic study of the present volume. A feature of the work which greatly enhances its utility is to be found in the careful bibliographies which at the end of each chapter refer the inquirer to additional sources of information on points which may specially interest him.

"ELEMENTS OF ELECTRO-MAGNETIC THEORY."

By S. J. Barnett, Ph.D. The Macmillan Co. 12s. 6d. net.

In this treatise the author tells us that his aim has been to present in systematic and definite form a simple, rigorous, and thoroughly modern introduction to the fundamental principles of electro-magnetic theory, together with some of the simpler of their more interesting and important non-technical applications. The work makes no pretence to completeness, but is written for the serious student of physics, who will make liberal use of more detailed treatises, of handbooks, and of journals, as occasion demands. We may add that the work is well arranged, and will be found of considerable help to the student. Many of the pages in the copy before us have been marred by off-setting in the printing, a defect which will, no doubt, be removed in any subsequent edition of the work. The following is a synopsis of contents: General Electrostatic Theory—Ideal Electric Fields and Condensers with Homogeneous Dielectrics—Standard Condensers, Condenser Systems, Electrometers—Electric Fields with Two or More Dielectrics—Reversible Thermal Effect, Electro-striction—Electric Absorption, Electrets—Comparison of Dielectric Constants, Specific Inductive Capacity—The Electric Conduction Current, Intrinsic Electromotive Force—Electrolytic and Metallic Conduction—Thermal and Voltaic Electromotive Forces—Magnets, Magnetostatic Fields—The Magnetic Field of the Conduction Current — Electro-magnetic Induction — Units and Dimensions—Convection and Displacement Currents, the General Electric Current—The Flux of Electromagnetic Energy, Electric Waves.

OUR DIARY.

April.

22nd.—The railhead on the Cape to Cairo Railway is now within three miles of the Victoria Falls.

23rd.—The *Times* Johannesburg correspondent learns that a project for the federation of the South African railways is being entertained.

27th.—H.M.S. *Widgeon*, a twin-screw, shallow-draught gunboat, makes a trial run in the Thames.—A House of Commons Committee rejects the London, Camberwell, and Dulwich Tramway Bill.

28th.—The King lays the foundation stone of the Royal College of Science new buildings, Dublin.—The Marylebone Borough Council decides against the proposals of the Metropolitan Electric Supply Company and adheres to its own scheme for the erection of a local generating station.—A House of Commons Committee approves of the L.C.C. Bill for providing a passenger steamer service on the Thames.—The Cape Colony Premier states that nothing has been done respecting the amalgamation of the South African Railways excep the mooting of proposals for a conference.

29th.—Launch of the steamship *Conway* at Newcastle-on-Tyne, and of the turbine steamer *Londonderry* at Dumbarton.—Mr. Cecil Edge completes a 2,000 miles run in a motor-car.

30th.—Opening of the World's Fair at St. Louis.—Launch of the first-class cruiser *Devonshire* at Chatham.—The New South Wales revenue for the past ten months amounts to £9,416,457.

May.

1st.—The Great Western Railway Company inaugurate a service of motor-coaches between Westbourne Park and Southall.

2nd.—The Society of Engineers holds its Jubilee meeting.

3rd.—Opening of the new Greenland Dock at Rotherithe.—Mr. Cosmo Bonsor opens the Queensborough new pier which has cost £120,000.

4th.—Opening of the Bradford Exhibition.—The South Wales Coal Owners' Association serve upon the miners a demand for a 5 per cent reduction off their wages; simultaneously the South Wales Miners' Federation demand an increase of 3¾ per cent.

5th.—The Iron and Steel Institute open its annual meeting.

6th.—The Canadian Government decide to purchase the Canada Eastern Railway of New Brunswick for £160,000.

9th.—The Egyptian Government decides to entrust to Sir William Arrol and Co. the construction of the Nile bridges at Rodah Island, near Cairo.

11th.—The *Times* reports that Mr. Flint, of New York, has bought the Chilian cruisers *Esmeralda* and *Chacabuco* for the sum of £1,030,000.—It is announced that the Great Western Railway Company have completed arrangements for the equipment of a section of their main line with electrically-controlled signals.

13th.—The eliminating trials for the selection of motor-cars to represent England in the Gordon-Bennett race begins in the Isle of Man.—The convention with China relative to the importation of Chinese labour into the Transvaal is signed at the Foreign Office by representatives of the two Governments.

14th.—Issue of a Blue Book on native labour in the Transvaal.—At a meeting of the Conciliation Board the South Wales Coal Owners' Association and the Miners' Federation agree to withdraw their respective claims.

16th.—The German Steel Trust, reduction in the export bounty on half-finished steel is from 15s. to 12s. 6d. per ton.

19th.—Issue of a Parliamentary Paper containing the text of the convention between the British and Chinese Governments, respecting the employment of Chinese labour in British Colonies and Protectorates.

20th.—Professor E. Rutherford lectures at the Royal Institution on "The Radiation aud Emanation of Radium."—The Labour Importation Ordinance declared operative in Pretoria.—The New York dock strike threatens to assume serious proportions.—The steamship companies announce their dermination not to grant the demands of the strikers.

NEW CATALOGUES AND TRADE PUBLICATIONS.

J. H. Sankey and Son, Ltd., Canning Town, E., forward Section S of their catalogue, giving a complete list of sanitary appliances. Sections can also be obtained dealing with fireclay goods, and brick cement, etc.

From Raevels Portland Cement Works, Antwerp, we have received a summary of results printed in English, French, and German, relating to tests in various European laboratories of Raevels' Falcon brand of Portland cement.

Sturtevant Engineering Company, Ltd., send us No. 3 of their series of picture postcards and invite us to make choice of catalogues dealing with forge fans—cupola fans—ventilating fans—mechanical draught for boilers—dust exhausting, chips shavings and sawdust removal drying—heating and ventilating—forges and forge plants—exhaust steam pipe heads—steam traps—and motor controlling apparatus.

The United States Metallic Packing Company.—The most recent booklet issued by this firm is attractively bound in red and gold, and deals with the claims to pre-eminence of the United States Metallic Packing. It is a collection of letters received from clients of the Company throughout the country detailing their experiences. In some cases it is shown that these packings have been in service for over 12½ years working day and night, equal to 25 years' ordinary service. The letters from users of the packing are arranged territorially, so that anyone can look up the opinions from his own district.

Fr. Meguin and Co., Ltd.—Mr. Andrew Brown, sole agent in the United Kingdom for this firm, forwards their illustrated catalogue of perforated iron, steel, copper, zinc, and brass, in sheets and plates up to one inch thick. The diagrams and tables in this book have been produced with great care and ensure a minimum of trouble to the user. It has useful tables showing the equivalents of the English and German zinc gauges in decimals of an inch and also in millimetres with weights per square foot. Mr. Andrew Brown, writing from 110, Cannon Street, E.C., advises us that he has also been appointed London and District Agent for Messrs. G. B. Smith and Co., of Craighall Iron Works, Glasgow.

William Ryder, Ltd., forward an attractively-printed catalogue, the first page of which runs, "Established 1832, William Ryder, Ltd., Original Inventors, Patentees, and Makers of Ryder's Forging Machines, General Tool Makers, Bee-Hive Works, Bolton, Lancashire." We are reminded that the machine has been used for every kind of swaging work, for making shells, drawing tubes, making spikes, spindles and flyers, bayonets, studs, shaft ends, etc., and is largely used for repetition work by engineers, millwrights, machinists, tool-makers, bolt-makers, shipbuilders, etc. It is a significant fact that the firm use some twenty-four of these forging machines in their works, while over 1,000 have been manufactured for use in the United Kingdom and abroad.

G. and J. Weir, Ltd., in an admirably printed and illustrated booklet—Sectional Catalogue No. 4—show their latest and most improved designs in Feed and Service Pumps for power plants. The catalogue is well arranged. Following an introduction and some remarks on feed pumps generally, we come successively to the question of price, the steam consumption of pumps, steam feed pumps *v.* electric feed pumps, a dozen points about Weir feed pumps, and the Weir steam valve. The following sections are devoted to Weir feed pump, series III.; the Weir tandem compound feed pump; the Weir twin compound feed pump; the Weir service pump, and the Weir tandem compound service or tank pump. The booklet has some useful instructions for fitting up, and presents complete information as to sizes, dimensions, and specifications.

Shand, Mason and Co.—From this firm we have received a complete set of sectional catalogues bound in an attractive cover and comprising manual fire engines, portable fire appliances, fire escapes, hose carriages and reels, fire brigade accessories, uniforms and accoutrements, fire hydrants and fire hose. Besides being well printed and illustrated, this volume deserves special mention by reason of its excellent arrangement for ready reference. From the introductory note we gather that the experience of the firm extends over a period of 130 years, the business having been originally established by Phillips in 1774. These catalogues form an extensive index to modern fire appliances and are supplemented by several pamphlets descriptive of the firm's "double vertical" steam fire engine. We gather that over 250 of these engines have been placed in various parts of the country.

Mather and Platt, Ltd., mechanical, electrical, hydraulic and fire engineers, Salford Iron Works, Manchester, issue a finely printed second edition of their Engine Catalogue, illustrating the design and capacity of the various steam engines which they have standardised and adapted, whether for coupling direct to electrical generators or pumps, or for use as prime movers in mills and power plants generally. It is remarked that one of the most important points in the selection of an engine is strength—combined, of course, with neatness of design—giving a capacity for hard and continuous work under widely varying conditions of load, and in this connection the firm mention that they have built engines which work continuously for periods of seven months, without a single stop, day or night, at 25 per cent. above the output for which they were designed.

Booker and Sullivan.—Every engineer at some time or other has to call in the aid of the photographer, and it soon becomes evident that engineering photography is a very special branch of the business. Messrs. Booker and Sullivan have specialised in this direction, with the result that they are able to combine technical skill of a high order with the regular stock-in-trade of the photographer. The firm send us a small booklet which concisely states all that an engineer can reasonably want to know, and incidentally we learn what the firm is prepared to do in the way of photographing small objects sent to their studios clearing backgrounds, furnishing machine printed bromides in cases where a large quantity of prints are required at low rates, making enlargements and photographing works. Several engravings are included, illustrating the special difficulties encountered in photographing engineering subjects, and showing how they are met by Messrs. Booker and Sullivan, of 67 and 69, Chancery Lane, W.C.

No. 1. Vol. 4. ONE SHILLING NET. JANUARY, 1904.

PAGE'S MAGAZINE

ENGINEERING · ELECTRICITY SHIPBUILDING MINING IRON & STEEL INDUSTRIES

EDITORIAL & PUBLISHING OFFICES, CLUN HOUSE, SURREY STREET, STRAND, LONDON, W.C.

FRANCE, Paris : 22, Rue de la Banque.
GERMANY, Berlin : 5, Unter den Linden.
[illegible]SSIA, [illegible] Nevsky P[illegible]spect.
[illegible]STRIA, Vienna : [illegible]strasse, nr. 30.

INDIA, Calcutta : Thacker, Spink & Co.
" Bombay : Thacker & Co., Ltd.
SOUTH AFRICA, Cape Town : Gordon & Gotch.
JAPAN, Yokohama : [illegible]

CANADA : Montreal News Company.
UNITED STATES, New York : International News Co.
Chicago : Subscription News Co.
AUSTRALIA, Melbourne : Gordon & Gotch.

No. 2. Vol. 4. ONE SHILLING NET. February, 1904.

PAGE'S MAGAZINE

ENGINEERING · ELECTRICITY
SHIPBUILDING MINING
IRON & STEEL INDUSTRIES

EDITORIAL & PUBLISHING OFFICES. CLUN HOUSE, SURREY STREET, STRAND, LONDON, W.C.

FRANCE. Paris: 22, Rue de la Banque.
GERMANY. Berlin: 5, Unter den Linden.
RUSSIA. St. Petersburg: 14, Nevsky Prospect.
AUSTRIA. Vienna: [illegible]

INDIA. Calcutta: Thacker, Spink & Co.
Bombay: Thacker & Co., Ltd.
SOUTH AFRICA. Cape Town: Gordon & Gotch.
JAPAN. Yokohama: Kelly & Walsh, Ltd.

CANADA: Montreal News Company.
UNITED STATES. New York: International News Co.
Chicago: Subscription News Co.
AUSTRALIA. Melbourne: Gordon & Gotch.

Nº 3. Vol. 4. ONE SHILLING NET. March, 1904.

PAGE'S MAGAZINE

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France: Paris: 22, Rue de la Banque.
Germany: Berlin: 5, Unter den Linden.
Russia: St. Petersburg: 14, Nevsky Prospect.
India: Calcutta: Thacker, Spink & Co.
Bombay: Thacker & Co., Ltd.
South Africa: Cape Town: Gordon & Gotch.
Canada: Montreal News Company.
United States, New York: International News Co.
Chicago: Subscription News Co.

No. 5. Vol. 4. ONE SHILLING NET. May, 1904.

PAGE'S MAGAZINE

ENGINEERING · ELECTRICITY SHIPBUILDING MINING IRON & STEEL INDUSTRIES

EDITORIAL & PUBLISHING OFFICES, CLUN HOUSE, SURREY STREET, STRAND, LONDON, W.C.

FRANCE. Paris: 22, Rue de la Banque.
GERMANY, Berlin: 5, Unter den Linden.

INDIA, Calcutta: Thacker, Spink & Co.
" Bombay: Thacker & Co., Ltd.

CANADA: Montreal News Company.
UNITED STATES, New York: International News Co.

No. 6. Vol. 4. ONE SHILLING NET. June, 1904.

PAGE'S MAGAZINE

ENGINEERING · ELECTRICITY SHIPBUILDING MINING IRON & STEEL INDUSTRIES

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FRANCE, Paris : 22, Rue de la Banque.
GERMANY, Berlin : 11, Unter den Linden.
RUSSIA, St. Petersburg : 14, Nevsky Prospect.
AUSTRIA, Vienna : Karntnerstrasse, nr. 30.

INDIA, Calcutta : Thacker, Spink & Co.
Bombay : Thacker & Co., Ltd.
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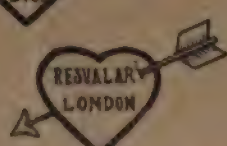

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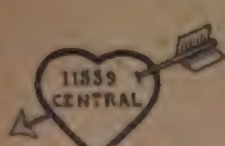

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General Managers.

For contents of the Magazine for the month, see pages 2 and 4. Index to Advertisers, pages 41, 43, 44, and 46.

CONTENTS.

No. 6. JUNE, 1904. Vol. IV.

SPECIAL ARTICLES.

(Continued on Page 4.)

BY ROYAL WARRANT TO H.M. THE KING

W. & T. AVERY LTD

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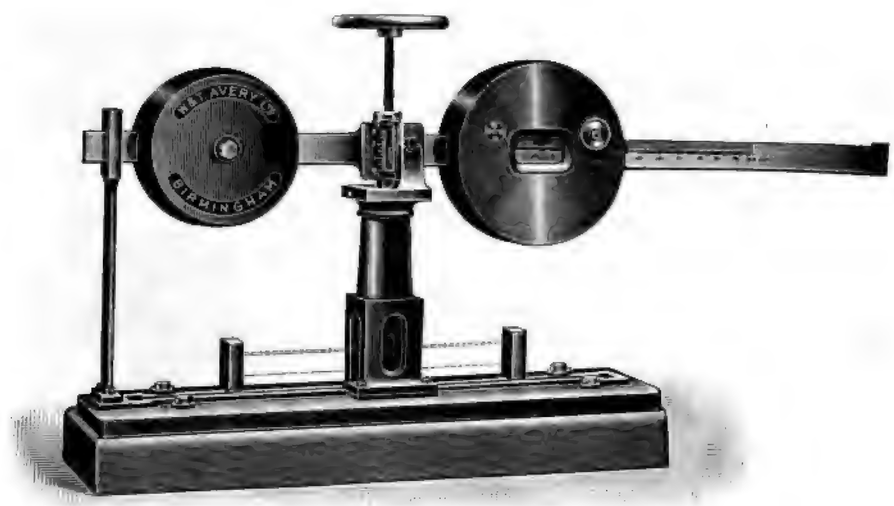

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CONTENTS.

(*Continued from Page 2.*)

PROGRESS OF THE ENGINEERING WORLD.

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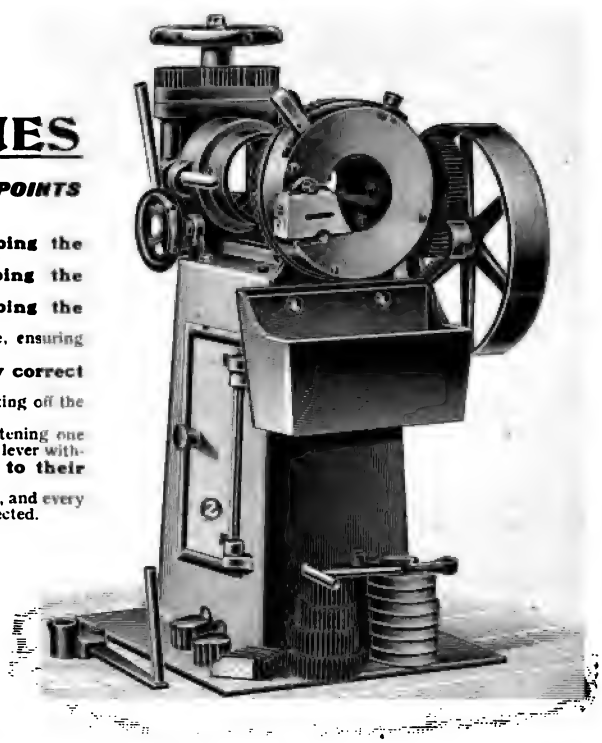

Are the only ones which have ALL of the following POINTS OF SUPERIORITY :—

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DAVIDGE PAGE, Editor,

Clun House, Surrey Street, Strand, London, W.C.

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Telegraphic and Cable Address: "SINEWY, LONDON."

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All inquiries regarding Advertisements should be directed to "THE ADVERTISEMENT MANAGER, Clun House, Surrey Street, Strand, London, W.C."

Copy for Advertisements

should be forwarded on or before the 3rd of each month preceding date of publication.

Editorial.—*All communications intended for publication should be written on one side of the paper only, and addressed to "The Editor."*

Any contributions offered, as likely to interest either home or foreign readers, dealing with the industries covered by the Magazine, should be accompanied by stamped and addressed envelope for the return of the MSS. if rejected. When payment is desired this fact should be stated, and the full name and address of the writer should appear on the MSS.

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Correspondence *is invited from any person upon subjects of interest to the engineering community. In all cases this must be accompanied by full name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

BUYERS' DIRECTORY.

NOTE.—The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index to Advertisers on pages 41, 43, 44, & 46.

In order to assure fair treatment to advertisers, each firm is indexed under its leading speciality ONLY.

Advertisers who prefer, however, to be entered under two or more different sections can do so by an annual payment of 5s. for each additional section.

Artesian Well Machinery.
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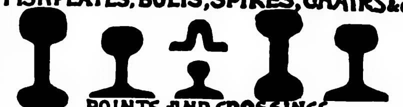

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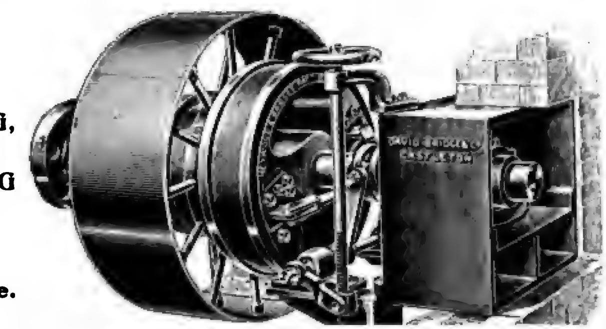

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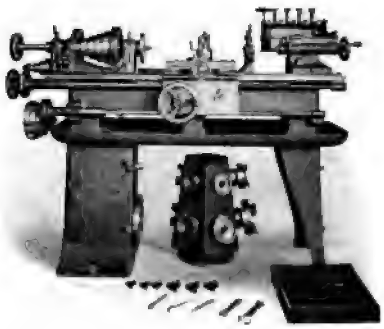

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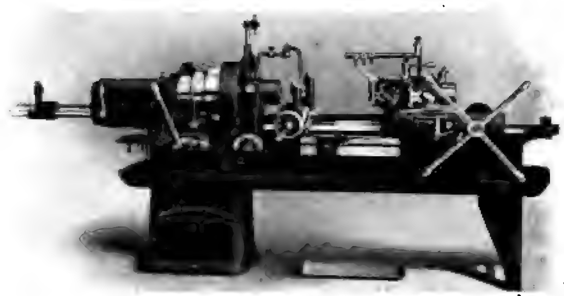

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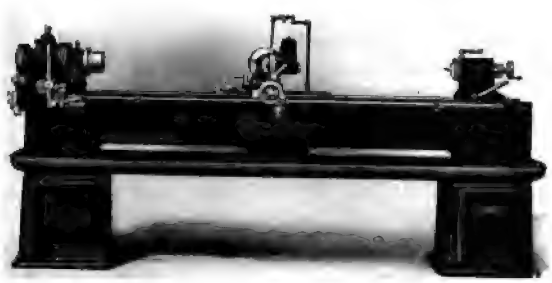

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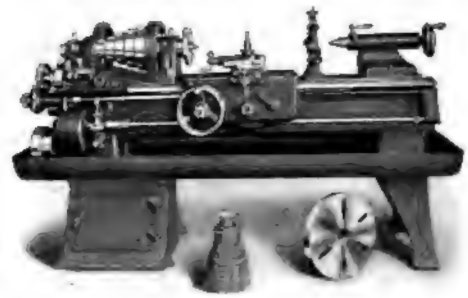

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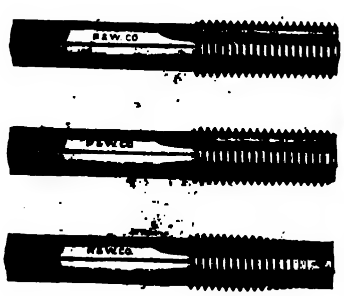

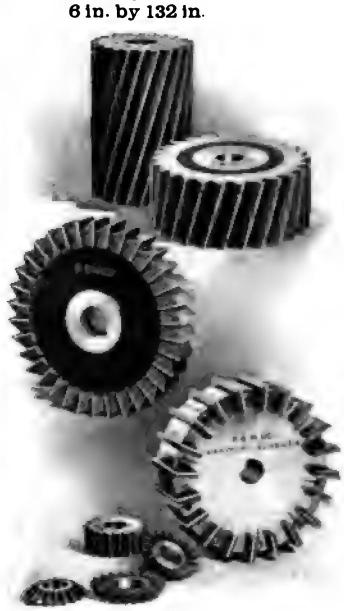

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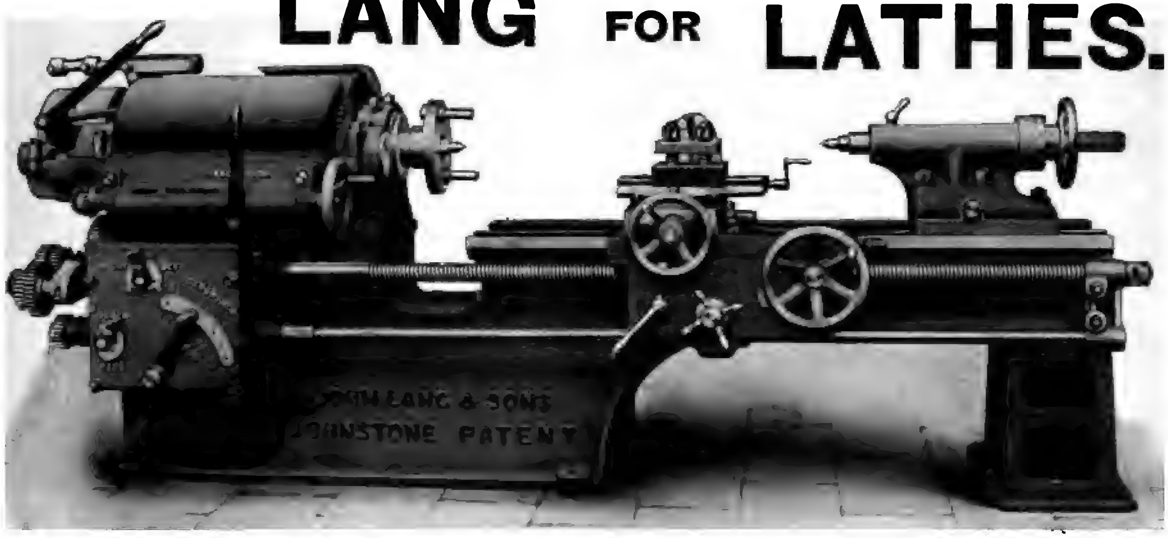

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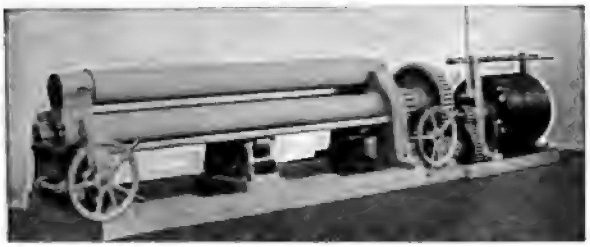

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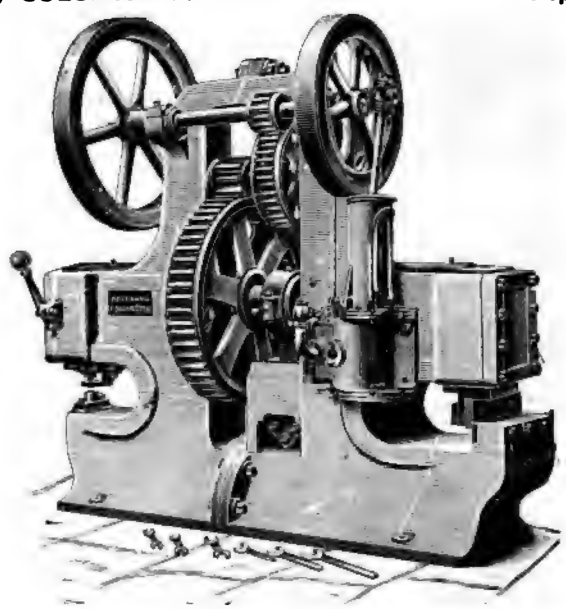

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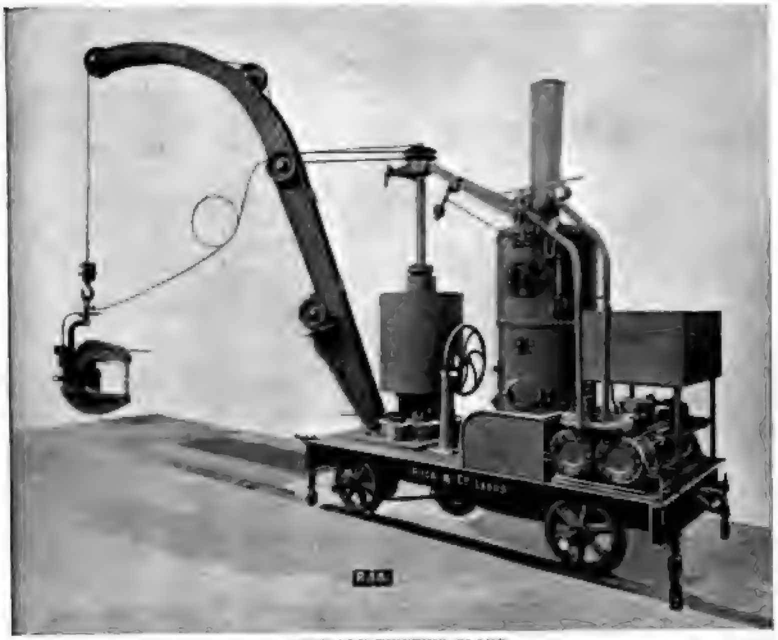

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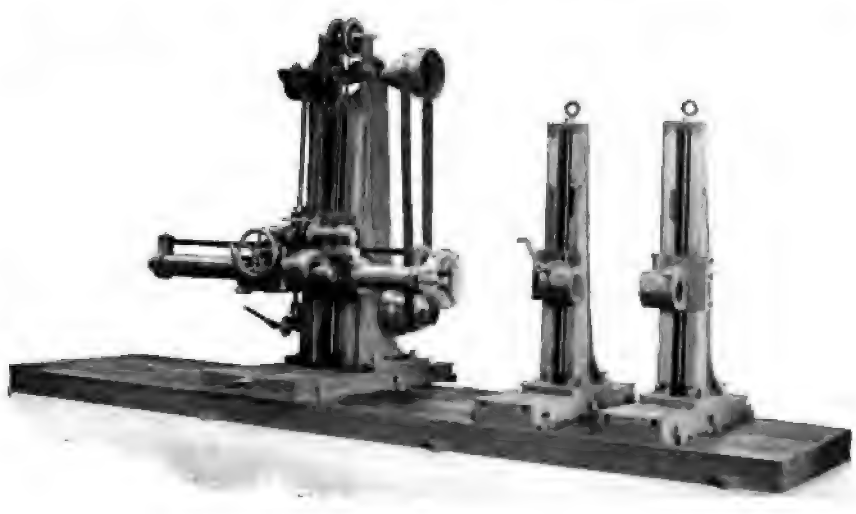

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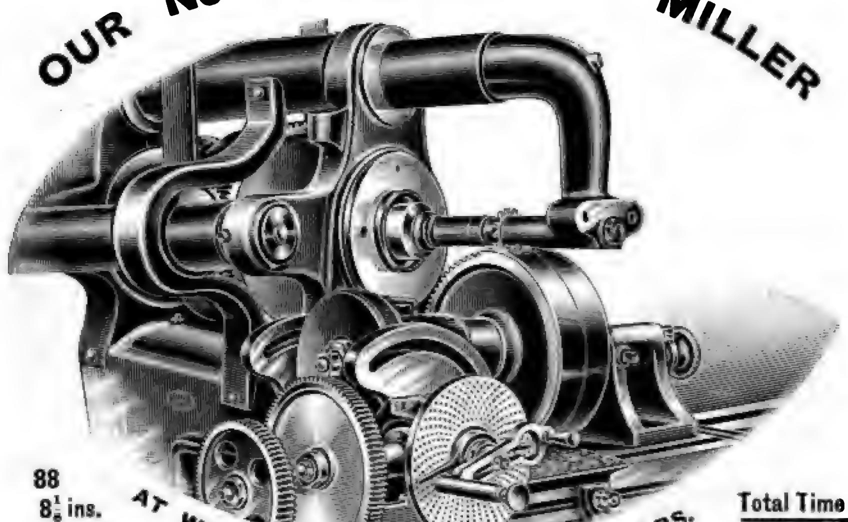

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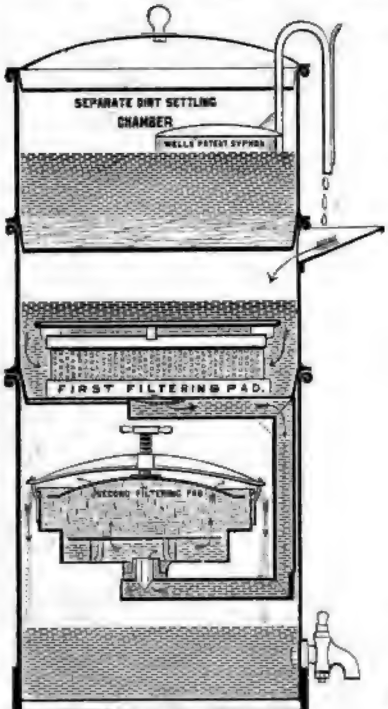

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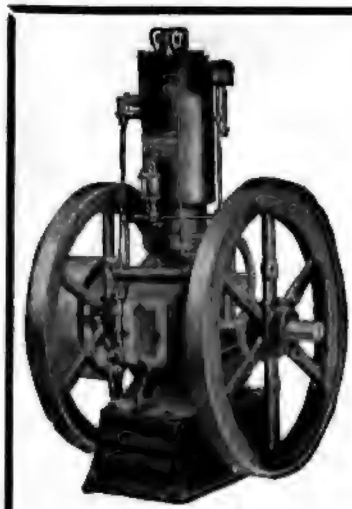

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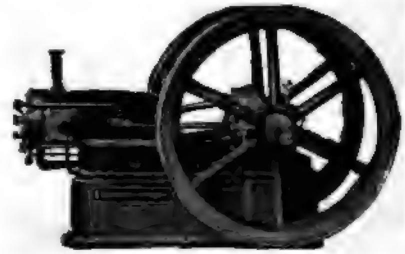

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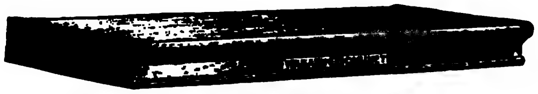

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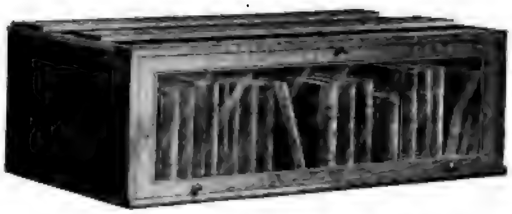

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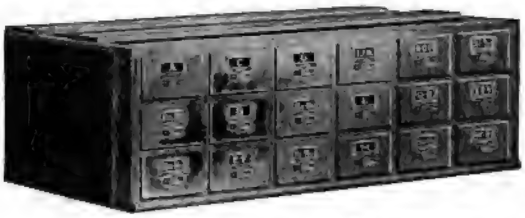

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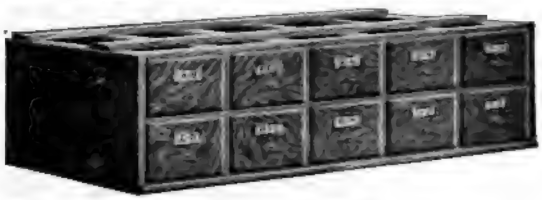

No. 64. Card Index Section. 6 by 4 Cards.

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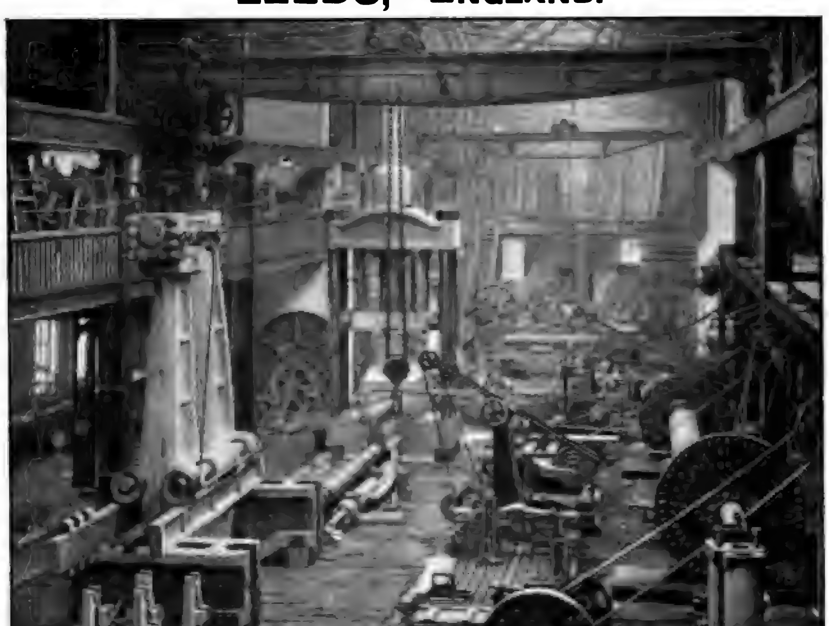

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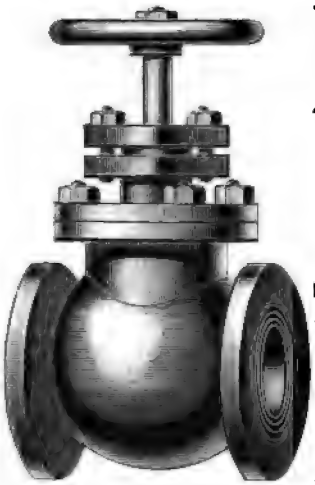

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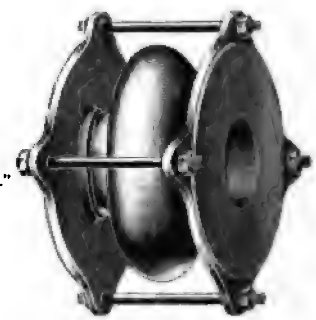

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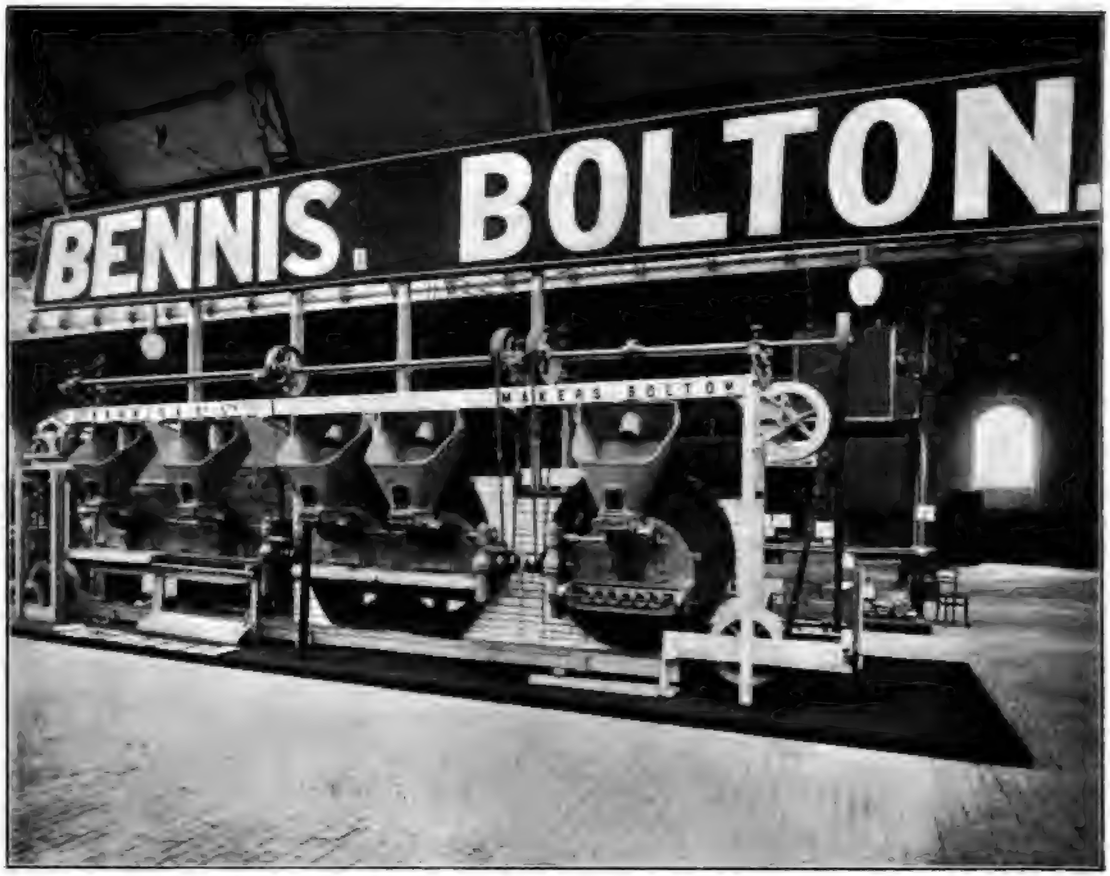

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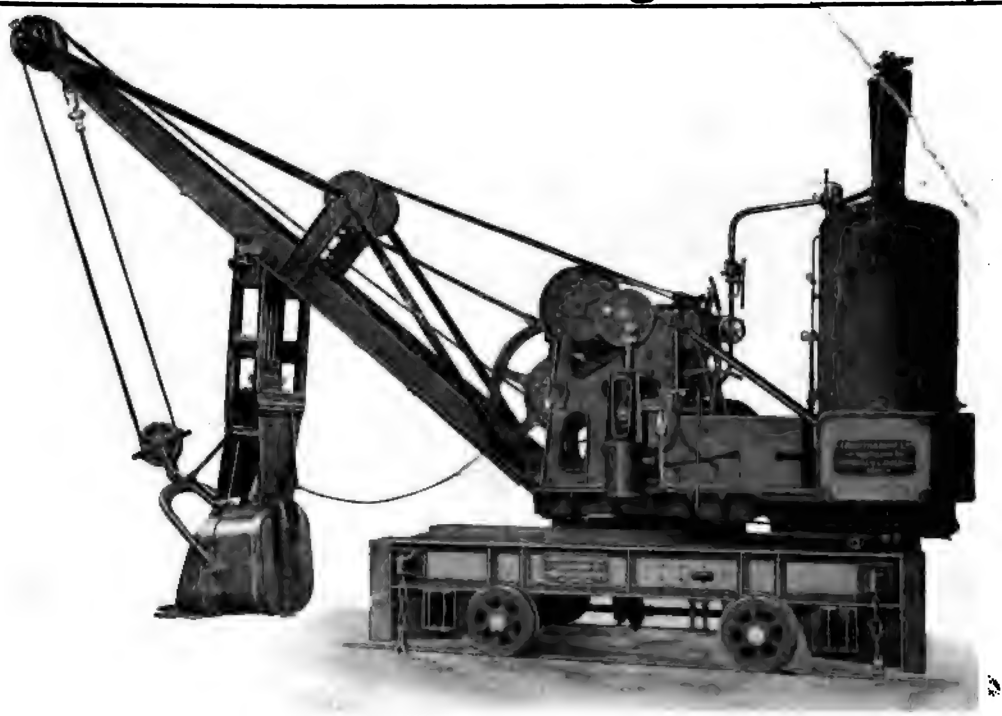

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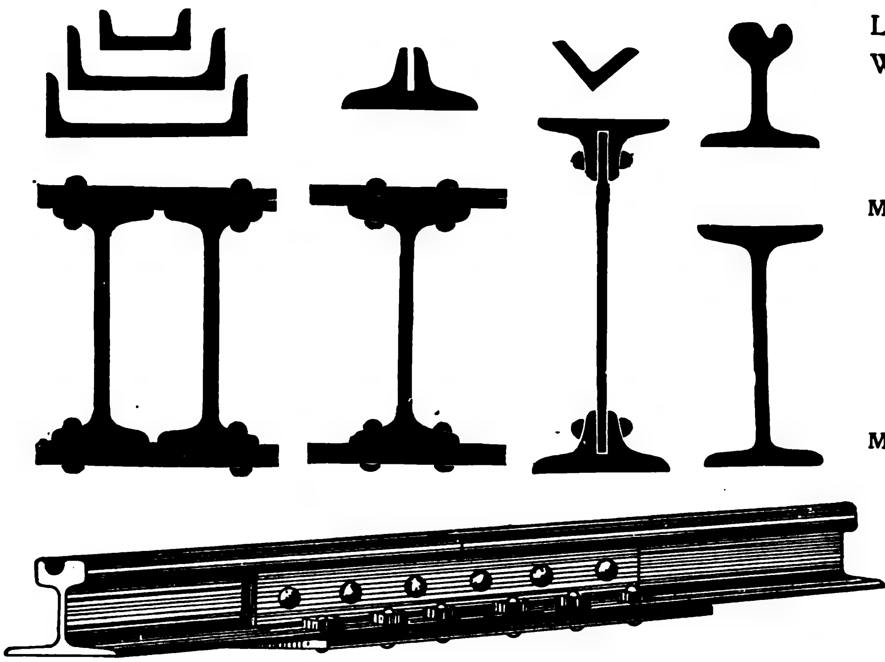

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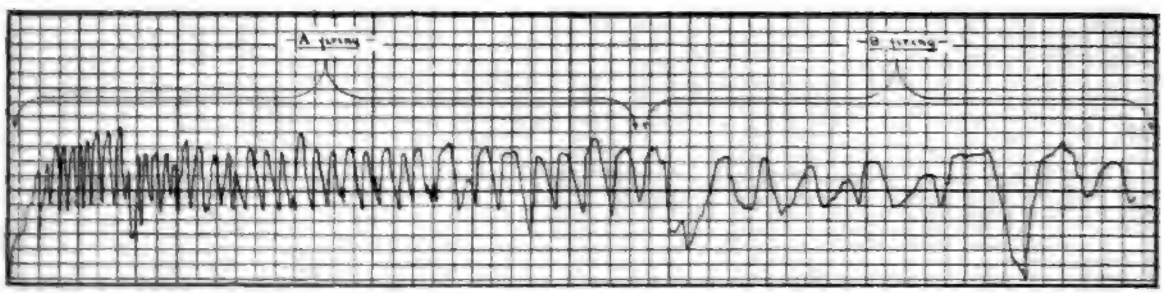

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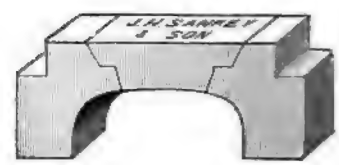

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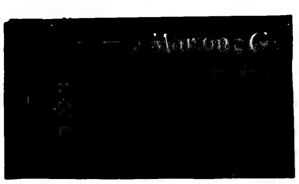

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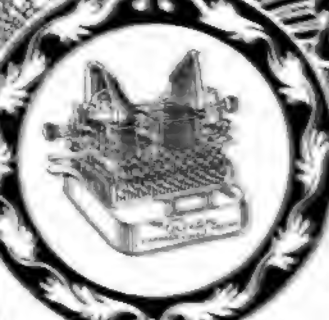

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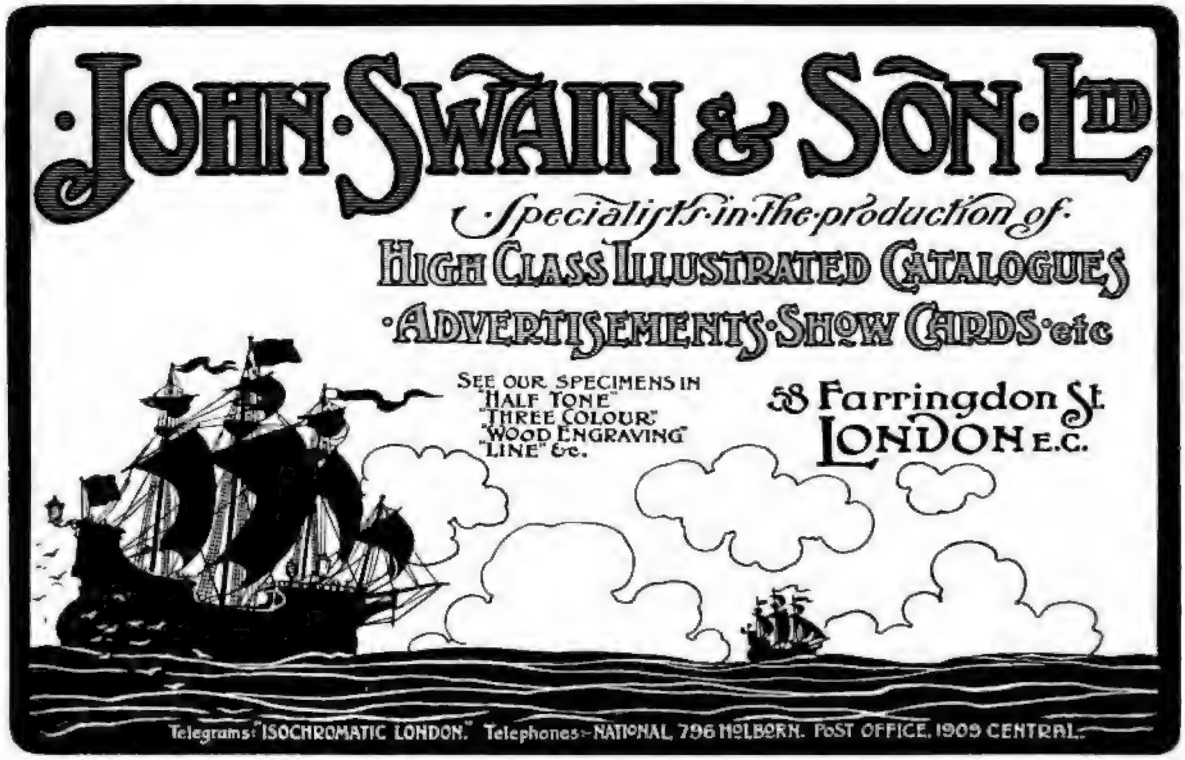
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